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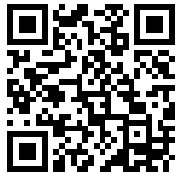

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NOTICE.

THE ROYAL ENGINEERS JOURNAL.

It has been decided that, after the completion of the present volume, the ROYAL ENGINEERS JOURNAL *shall be published quarterly instead of monthly. In January and February,* 1923, *no* JOURNAL *will be issued, and the first quarterly* JOURNAL *will be published on* 1st *March,* 1923. *The size of the quarterly* JOURNAL *will be considerably greater than that of the monthly one, and its price has been fixed at* 5/-.

AN OUTLINE OF THE EGYPTIAN AND PALESTINE CAMPAIGNS 1914—1918.

By MAJOR-GENERAL SIR M. G. E. BOWMAN-MANIFOLD, K.B.E., C.B., C.M.G., D.S.O., *p.s.c.*

PREFACE.

THIS outline of the campaigns which took place in Egypt, Sinai and the Western Desert in 1914, 1915 and 1916, Palestine in 1917, and which culminated in Syria and Cilicia in 1918, presents the main features only of those campaigns, and their relation to the events in adjoining theatres of operations. Originally, it was prepared as a course of lectures for the Staff College, Camberley; and in response to numerous requests, it is now re-drafted and published in the hope that it will serve as a concise narrative of an interesting and progressive series of campaigns. Most of the maps and plates, compiled from official sources, were printed by the Ordnance Survey for that course of lectures and have been reproduced for this book with the kind permission of the Controller of His Majesty's Stationery Office.

I am grateful to many brother officers for their helpful suggestions, and particularly to Major-General G. P. Dawnay, Brig.-General J. E. Edmonds, and Colonels W. H. Bartholomew and T. E. Lawrence for the valuable information which they put at my disposal.

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CHAPTER I.

THE SITUATION BEFORE TURKEY JOINED IN THE WAR.

THE SITUATION BEFORE TURKEY JOINED IN THE WAR.—Growth of German Influence in Turkey—Causes which led to Turkey entering the War—The Turkish Empire—The Immediate Effects of Turkey's Declaration of War—Railways in Turkey and Syria—The Turkish Army; its lack of Homogeneousness—Qualities of the Turkish Soldier—Initial Concentration—Egypt; Peculiar Political Conditions—Attitude of the Population—Desert Frontiers—The Suez Canal—Troops in Egypt: 42nd Division—Indian Divisions, Australian and New Zealand Divisions—The Egyptian Army and Coastguards.

TURKEY declared war on Great Britain on 30th October, 1914. Her neutrality before that date was distinctly benevolent towards Germany. It is known now that, on 4th August, the Kaiser had informed the Greek Minister in Berlin that an alliance existed between Germany and Turkey. However, at the outset Turkey advertised her neutrality; but, even in August, it was evident that she was preparing for an invasion of Egypt.

For many years back Germany had been working for influence in Constantinople. The Kaiser had visited Abdul Hamid; and in 1898 had toured in Palestine, conducted by Mr. Cook. Krupp's had large contracts for the Turkish Army; and von der Goltz, and the German Military Mission under Liman von Sanders, were engaged in reorganizing the Turkish forces. The Bagdad Railway Concession had been secured; and work on that line was in full swing. German colonies in Palestine were thriving. German trade in Egypt was booming. The peaceful penetration of Turkey had been accomplished before 1914.

In 1914, German influence was paramount in Constantinople, and that Turkey did not enter the war at once was merely because it did not appear convenient to the Central Powers to bring her in. It may be surmised that, if Germany had brought off her coup in 1914 successfully, the Turkish Army—intact—would have been a very valuable weapon in Germany's hands to use against either Russia or Great Britain to back up German demands and peace terms.

Many factors combined to influence the operations in Egypt. Egypt occupies a unique position; it is a connecting link between Europe, Asia and Africa; it is the meeting-ground of East and West; and so it was peculiarly sensitive to events in both distant and adjacent theatres.

The war in Europe, to begin with, did not go as smoothly as Germany had forecasted. Great Britain came in. Russia's expedited mobilization, and prompt invasion of East Prussia, was another upset, Germany's reverse on the Marne in September, a third; and, she had made no effective progress during October. It was disappointing that reinforcements for Britain were pouring

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in from overseas Dominions and India. The Austrians had been hammered at Lemberg, and were finding the Russians too much for them. Germany felt that the attention of Great Britain, and of Russia, must be diverted from Europe, and so brought Turkey into the War at the end of October, 1914.

Turkey had mobilized in August. The arrival of the *Goeben* and *Breslau* at Constantinople had greatly strengthened her in the Black Sea. Turkish opinion was indignant with Great Britain for commandeering the battleships approaching completion for Turkey in her shipyards. Public subscriptions had been raised for these vessels, and the Turks had been conscious of their naval weakness as regards both Russia and Greece. An excuse for hostilities with Russia was easily found by interfering with Russian vessels in the Black Sea. The moment was not altogether advantageous to Turkey, as Rumania, Bulgaria and Greece were still neutral and the supply of war material across these countries was hampered as soon as Turkey became an open belligerent.

Turkey to-day is but the remnant of a great empire, but one with a brilliant history of conquest. Her sway once had extended to Vienna and Odessa, the Caucasus, Persia and into Central Africa. The Turks of Europe and Asia Minor are proud of their fighting powers, and are willing to be led to repeat their exploits. Their Empire is built up of many races, but there is one predominant creed. Turk and Arab and Kurd in the main are sincere Moslems.

The Turks recognized Russia as their traditional enemy. She stood as the liberator of Non-Moslem territories from their rule. She aimed at supplanting them in Constantinople. Great Britain was conniving in Russia's aims. Although the Turk is naturally apathetic, he will respond when Russia is the immediate enemy, and his religion can be worked upon.

In Turkey itself, the political situation was that she possessed liberal institutions only in name. Power was centred in a small military group, of whom Enver and Talaat were the moving spirits. This group was tied to Germany, and in her control. The moderate parties were powerless to interfere.

Turkey did not enter the War for nothing: the incentives put before her were:—The recovery of her lost provinces from Russia and from Great Britain; and territorial gains from Persia—always under the tutelage of Germany.

The immediate effects of Turkey joining into the War were:—To close the Black Sea trade of the *Entente* with Russia and Rumania; to oblige Russia to retain more troops in the Caucasus; and to compel Great Britain to take more active steps to safeguard the Suez Canal, Egypt, and her great oil interests in Southern Persia. Also, there seemed a fair prospect that Moslem sympathies might be raised in Egypt, and in India, and revolts ensue.

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The Turkish Empire geographically is very extended, and it contains remarkable physical features—mountain ranges, great rivers, lakes and vast deserts—which separate its fertile and populated spaces. In time of peace, Turkey was largely dependent upon transport by sea. Constantinople itself is at an extreme end of the Empire, and owes its strategical importance to the control it can exercise upon sea communication.

Turkey's artificial means of communication are poorly developed, and incomplete. Her great highways are those of Alexander, and have not been altered much, apparently. River transport is still in a medieval condition. Railways were very inadequate. A glance at the map will show how her main routes are hindered. Towards Armenia and the Caucasus, the railway stops 400 miles short of Erzerum, and troops must be maintained either by sea through Trebizond, or by poor roads over 5,000 ft. passes.

The Bagdad railway through Cilicia was a patchwork in 1914. It barely entered Mesopotamia. It was continuous only to Bozanti. (See *Plate* I.). The tunnels through the 11,000 ft. Taurus and 6,000 ft. Amanus ranges had not been pierced, nor was the formation drained. Traffic over these great mountain obstacles went by road; and, in the winter, was liable to prolonged interruption. Through trains were only able to run three weeks before the armistice. The railway stopped at Nisibin, 100 miles west of Mosul on the Tigris. Road and River transport had to be used to Tekrit, whence another railway extended to Bagdad. Coal was almost unobtainable, and the wood fuel was very inefficient. There were no proper workshops east of the Taurus, and the line was cumbered with locomotives and wagons awaiting repair. South of Aleppo, the broad gauge extended only to Rayak. There it met the Beirut-Damascus line, also French-owned, which is of 3 ft. 6 in. gauge with much rackwork over the Lebanon. From Damascus to Palestine and Arabia, the Hedjaz Railway and its branches furnished fairly good transportation: on 3 ft. 6 in. gauge. But these lines suffered also from fuel and water difficulties. The Hedjaz Railway stopped at Medina, 250 miles from Mecca, the desired terminus. In Palestine, there was one branch line from Deraa down the Yarmuk valley to Haifa, also a French-owned line from Jaffa to Jerusalem. Observe how all the railways avoided the coast; the Turk had a wholesome respect for our disembarking propensities.

The Turkish Army was organized to form 15 divisions; and 15 more were rapidly raised when war broke out. This gave nearly 300,000 men to start with. Ultimately, Turkey had nearly 50 divisions—never complete—approximately 800,000 men. But, many of the best fighting troops, the peasants of Anatolia, had been expended in the last Balkan wars. The equipment of the army, too, had been dissipated, and had not been made up. Besides, there were

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the hindrances due to having to cross neutral territory, which impeded the completion of the army in war material, when hostilities commenced.

The army was not homogeneous in race, religion, or language. It comprised, besides Turks:—Arabs, Armenians, Circassians, Kurds, Syrians and Levantines of mixed European breed. Generally, the impression was that the troops were illiterate, and the officers scarcely educated and taken from the cities chiefly because they could read, write and add. Officer desertions were frequent.

The outstanding features of the Turkish soldier are his patience, hardiness and stubbornness in defence. But he seldom succeeded in the offensive; partly because he was poorly led and cared for. He did not like the German element in the army.

The fighting equipment of the troops was intended to be good, but their transport and supply system was poor; and the prevalence of corruption resulted in the field armies often being miserably deficient in clothing, food, and medical and technical stores. As the War progressed, the control of these services was taken over more and more by Germans and Austrians. They supplied the Flying Corps, Telegraphs, Mechanical Transport and Railways. The Austrians specialized in the Artillery and Medical Branch.

In 1916, special reinforcement troops were organized in Germany—the "Pasha" formations—and, during 1917 and 1918 three of these were sent to Palestine or Mesopotamia, and also an Asia Corps.

A Pasha Group consisted of:—

1 Battery. 1 Battalion. 1 Squadron. Technical Detachments.	About 1,700 men in all.

The Turkish troops which were already mobilized were in two main groups at the end of October, 1914. In Armenia, about Erzerum, Isset Pasha had four army corps, about 180,000 men, destined to invade the Caucasus. In Syria and Cilicia, Jemal Pasha had about 140,000 men. These were grouped about Aleppo and Damascus to protect the coast, or to operate in Mesopotamia, Arabia, or towards Egypt, as required.

Lord Milner summed up Egypt truly as "the land of paradox." Many things there are peculiar: our position in the country was certainly anomalous. Egypt was a recognized dependency of Turkey, to whom she was paying an annual tribute; and yet Great Britain had been occupying, and in fact controlling, this nominal Turkish Dominion for 32 years.

The Khedive, Abbas II, was obviously inimical to Great Britain, as he supported the Nationalist party in Egypt, and was intriguing with the Germans. When war broke out he was in Constantinople.

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His uncle, Hussein, was proclaimed Sultan, the suzerainty of Turkey was repudiated, and in mid-December, 1914, Great Britain announced a protectorate over Egypt. Martial law had been declared previously, and the Egyptians were informed that the British would defend their country.

The Egyptians, having been governed by the Turk, regarded him with mixed feelings. They stood in awe of Pashas, and yet had admiration for their Oriental methods of government. As good Moslems they reverence the Sultan as the temporal head of the Mohammedan world, and as keeper of the Holy Places. But, they do not want the Turk back as ruler in the land.

Towards the British, the mass of the people were apathetic. Our control was tolerated, not appreciated, and certainly not popular. Their interests were agricultural—not fleets, armies, or European squabbles. The political cry of "Egypt for the Egyptians" (before the War) met with little response from the masses—Fellahin or Bedouin.

The articulate and urban population of Egypt contains a large proportion of Europeans; it is very cosmopolitan—French, Italian, Greek, German, and the indefinite Levantine. The sympathies of this European element were not always pro-British and it provided fine soil for espionage and propaganda.

Fertile and habitable Egypt is merely the Nile Delta and its river banks, cultivated by the Fellahin. The rest is desert, some of which is occupied—sparsely—by nomad Arab tribes. The deserts on the east and south-east (Sinai and Red Sea Littoral) are mountainous. Except near the coast, water is scarce. To the west and south-west the barrier is illimitable sand, but it is remarkable for a belt of oases about 100 miles west of the Nile.

Egypt is peculiar in its communications. It possessed no metalled roads, except in the chief cities. Its chief means of transport were its railways (of many gauges), the Nile and its canals, the camel and the donkey.

Egypt is often called "rainless," but the northern coast gets a regular rainfall in January and February; and in both east and west the hills hold the rain for several weeks. There are many rock cisterns of very ancient origin, formerly known only to the Arabs. The movement of troops in these northern deserts is quite practicable for those who know their resources and limitations.

It is a popular fallacy that the Suez Canal is in Egypt itself. Actually, the Canal is some 30 miles from the habitable Delta, and it traverses the wilderness. The military aspects of the Suez Canal will be dealt with later on, but in connection with Egypt, two features of it may be mentioned now.

The towns along the Canal—Suez, Ismailia and Port Said—are entirely dependent on Nile water brought from Cairo, 100 miles

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by the "Sweet Water Canal," which is also navigable for Nile boats as far as Ismailia. At Ismailia this canal branches north and south to serve Suez and Port Said.

The Canal ports were connected to Egypt proper by a single line of railway from Zagazig (doubled from Zagazig to Ismailia only in December, 1915). No roads for vehicles existed either from the Delta to the Canal, nor along its banks.

When war ensued, Egypt became of immense importance to the Allies. Troops and supplies from India and the Dominions were streaming through the Suez Canal. The cable communications to the East passed through her territory. Egypt herself furnished many necessaries—cotton, grain, sugar and oil fuel. She was to serve as a rest camp and training ground; for the country had natural advantages, it was central, and it seemed difficult to assail.

The pre-war British garrison in Egypt was about 5,000 men; but the regular units comprised in it were soon required elsewhere. To replace them the 42nd (East Lancs.) Division (T.F.) was sent out from home by the end of September. India, too, was requested to furnish troops; and besides, the overseas troops from Australia and New Zealand were dispatched to Egypt to complete their equipment and training.

India sent off the Indian Expeditionary Forces—known officially as I.E.F. (E) and (F)—which later were formed into the 10th and 11th Indian Divisions. These began to arrive in the middle of November. The first Australian and New Zealand troops disembarked at Suez early in December. At the end of 1914, Egypt contained about 70,000 British, Dominion, and Indian troops, of whom only the Indian had completed their training.

The Egyptian Army, of Egyptians and Sudanese, about 22,000 in all, was necessarily employed almost entirely in the Sudan. Only its training depôts, and a few troops for guards, are normally stationed in the Delta. Still, the Egyptian Army was able to provide some artillery, and later several battalions for service in Egypt and Sinai.

The Egyptian coastguard was a body on a military basis, but not under the army. It was used to check smuggling over the desert, and was well equipped with camels. It contained a certain foreign element, and proved unreliable when tried in service. The camels, however, were kept on with the army.

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CHAPTER II.

THE TURKISH ATTACK ON THE SUEZ CANAL IN 1915.

THE TURKISH ATTACK ON THE SUEZ CANAL IN 1915.—The Checks to Turkey in Southern Persia and in the Caucasus—Commencement of the Move towards Egypt—Lines of Advance available—Some Military Aspects of the Suez Canal—The British Dispositions to meet the Attack—Organization of the Suez Canal Defences—The Turkish Advance in January, 1915—Attempts to force a Crossing at Serapeum on 3rd February—Retirement of the Turks—Absence of Pursuit—Observations.

THE Germans had early appreciated the importance to the *Entente* of the Suez Canal and Egypt. They realized how sensitive Great Britain would be even to a threat to hinder the free passage of her ships. They had called the Canal "the throat of England," and soon began to try and throttle her there. Ineffectual attempts were made to scuttle neutral vessels passing through the Canal. As a result an officer's guard was placed on every vessel and attempts to drop mines astern were specially watched for.

When Turkey was brought into the war, immediately she was set the task of raiding the Canal, with the further possibility of raising revolt in Egypt. She was also directed to engage Russia in the Caucasus; and, there was to be her own little enterprise into Persia. All three undertakings were soon under way; and Germany provided substantial aid for the first two in material and staff.

The move on Southern Persia was forestalled by India. The 6th Indian Division disembarked in the Persian Gulf on 6th November—a quick piece of work—and on 15th November Sir A. Barrett's troops defeated the Turks at Sahil, and opened the way to Busra. On 9th December the Turkish garrison of Kurna on the Tigris surrendered.

On the Caucasus border, the four army corps of Isset Pasha set out in November from Erzerum. A surprise march on Kars was planned. The Turkish lines of advance were very difficult, the snow was against them. The Russians had the advantage of railways and fair roads. General Vozonov fell on three corps in turn, and this group of the Turkish forces was almost destroyed.

The raid on Egypt was well organized, and carried through with rapidity and determination. The Turkish troops for this enterprise began to move early in November. Jemal Pasha had the 8th and 12th Corps, about six divisions, in south and central Syria. Of these, the force destined for Egypt comprised:—

10th Division
23rd Division } 3 Divisions, or 21 Battalions, and a large number of Arab auxiliaries.
25th Division

29th Cavalry Regiment.
2 6-in. howitzers.
2 Machine-gun Companies.
2 Engineer and Pontoon Companies.

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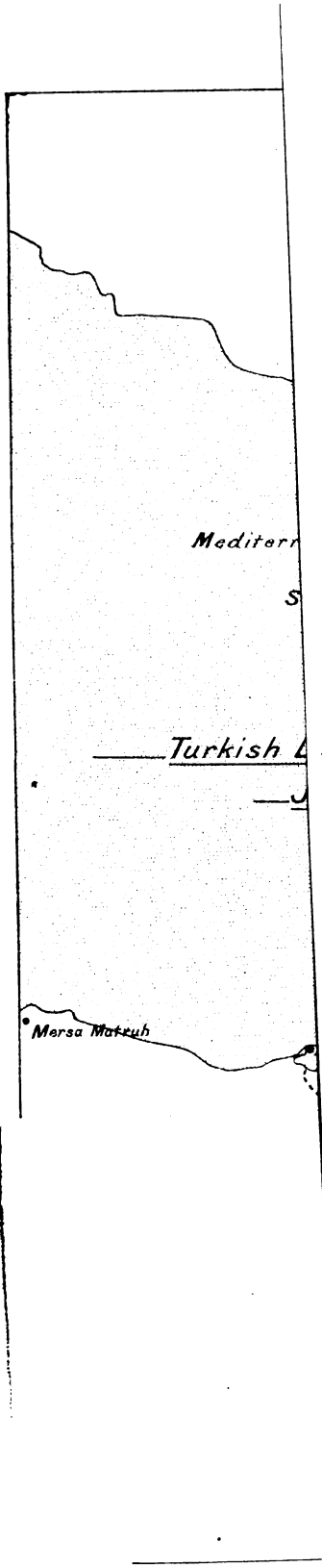

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In all, about 30,000 men, of whom 15,000 were to cross the Sinai Desert first. Jemal's Chief of Staff was a Bavarian, Colonel Kress von Kressenstein, a capable and energetic officer.

From their group position about Damascus, to the Sinai frontier, the Turks had the 3 ft. 6 in. gauge railway, Deraa–Afule–Haifa; also they had the Palestine backbone road, Afule–Nablus–Jerusalem–Hebron–Beersheba; and the Coast Road, Jaffa–Gaza–El Arish.

Beersheba was selected as the advanced base. The Hedjaz railway could be of no assistance beyond Deraa; the transport difficulties overland from Ma'an through Akaba were too great to render an advance from that direction possible.

The Sinai Desert consists on the north of a narrow coastal plain with sand dunes; and is from 5 to 15 miles wide. The sand carries a scrub suitable for camel grazing, but the going is very heavy for infantry or vehicles. The dune country merges into barren, stony hills rising to 3,000 feet in the centre; while the southern mass of the Peninsula is still more rough and precipitous. There are no roads for wheels anywhere. Water is scanty, except in the winter. Nomad Arabs occupy Sinai with their camel herds.

The Wadi el Arish—the Biblical "River of Egypt"—is a very extensive water channel. It is dry for nearly all the year; but usually has three or four spates, between December and February, when it comes down in a broad torrent for two or three days at a time. The town of El Arish is near its outlet, about two miles inland. It is the trade centre of Sinai, and is just 100 miles from the Suez Canal. The only other town in Sinai is Nekl, 60 miles east of Suez on the Akaba pilgrim track. Nekl also is on the Wadi el Arish and gets its water from rock wells.

Three lines of advance were at the choice of the Turks:—

(*i*) Along the coast from El Arish through El Abd and Katia;
(*ii*) Over the Sinai hills, from Beersheba or El Arish, by various tracks through El Hassana and Jifjaffa and Bir Hamme;
(*iii*) Part of the Pilgrim's Road from Nekl to Suez.

The coastal route has been used by armies from time immemorial. There are many wells, water is obtainable by digging on the beach. The inner tracks were more difficult, and normally the water is less assured.

But the Turkish Expedition was setting out just as the winter rains were due; and, until March, there would be pools on the *wadis*, and the wells and rock cisterns would be full. (One such pool and large rock cisterns were found in the Wadi Mushkeib). This central route was not liable to interference from the sea, and it was the one the British would least expect a large force to use.

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Jemal Pasha elected to use all three routes, but to send the principal part of his force across the centre of the Sinai Hills. The selection of the centre of the Suez Canal as his intended point of crossing also, doubtless, influenced the use of the hill routes for the main body.

The initial distribution of the Turkish column was approximately :-

Nekl Road.—Three battalions of infantry; mountain battery: 3,000.

Centre Road.—Six battalions infantry; heavy artillery; pontoon train: 6,000 or 7,000.

Coast Road.—Two battalions infantry; mounted troops and artillery: 3,000.

The Suez Canal is a formidable obstacle. The banks generally are raised from 5 to 25 feet above the desert level. The ship canal flows with a strong stream, whose direction varies with the wind, at a rate of about five miles per hour. The sweet water canal is only about 30 ft. across, and from 4 to 6 ft. deep.

The Suez Canal may be regarded in four subdivisions.

First, from Suez to the north end of the Great Bitter Lake; for some 40 miles the Canal traverses bare desert, and the two Bitter Lakes. The sweet water canal does not run close to the ship canal; and on the west side, except at Suez, there is no cultivated or habitable territory until the Nile is reached 80 miles away.

Next, between the north end of the Great Bitter Lake, and the north end of Timsah, at Ferry Post, for about 15 miles, the ship canal and the sweet water canal run close together; and there is a belt of irrigated land about half a mile wide along the latter; and this belt extends to Ismailia and Tel-el-Kebir, widening to over a mile about Ismailia.

Ismailia is an important town, the administrative centre of the canal. The Company's head offices and dockyard are there; besides, it is a railway junction, and has the lock gates and sluices for controlling the fresh water to Suez and Port Said. The Eastern Telegraph Company's land lines, from Alexandria and Cairo pass through Ismailia to Suez.

The *Third* subdivision extends from Ferry Post (Ismailia) to Kantara. At first the canal enters a deep cutting for two miles; then it runs through a very sandy stretch of desert for 18 miles. The sweet water canal is five miles away, until it rejoins the ship canal at Kantara. Beyond the sweet water canal is the bare desert—soft sand for 20 miles to the Delta.

The *Fourth* subdivision is the 25 miles from Kantara to Port Said. The two canals run close alongside each other, separated from Lake Menzala on the west by a narrow embankment. On the

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east lies the Plain of Tineh (mud!); much of it is below the sea level, and able to be inundated.

Considered from the enemy point of view, the choice of objectives on the canal reduces to a very few points.

(1) Suez to north of Bitter Lake—no good. A force which seized Suez would be in the air, 80 waterless miles from the Nile, and with its water cut off at Ismailia.

(2) Port Said to Kantara, similarly, the Lake Menzala is as bad an obstacle as the Suez–Mokattam desert.

(3) North-east of the Great Bitter Lake to Serapeum, and at Ferry Post, fresh water is available immediately the ship canal has been crossed. Ismailia railway junction and other resources are at hand; fresh water exists all the way to the Delta, and the sweet-water canal is navigable by Nile boats and launches. This section is specially attractive at Serapeum and Tussum, where the eastern canal bank is not in full view from the west bank.

(4) Between Ferry Post and Kantara the latter place offers the only attraction; elsewhere the fresh water is too far away. But the stretch of desert beyond rather rules out this section as a crossing-place. The conclusion is that the portion of the canal between the Bitter Lakes and Lake Timsah offers the best sites for crossing. Ferry Post is a second choice, Kantara a poor third.

Broadly, the British intention was to let the Turks first overcome the desert obstacle and to use the Suez Canal itself as a second obstacle. The plan was to strike at the enemy only when he arrived at the Suez Canal, where the defenders would have the benefit of ships' guns and armed launches—a purely passive defence.

At first, rather wild figures appeared as to the enemy's numbers. When Turkey declared war, Cairo noted that about four corps were on the Hedjaz railway, and the Turks had 40,000 armed Bedouin auxiliaries. But ten days later a former military attaché in Constantinople had estimated that not more than 70,000 Turks could be brought against Sinai.

General Sir John Maxwell, commanding the force in Egypt, formed the Suez Canal defences into a separate command under Major-General A. Wilson. The latter had the 10th and 11th Indian Divisions (six infantry brigades), Imperial Service Cavalry Brigade, and Bikaneer Camel Corps; in all, about 30,000 men. Besides, as previously mentioned, in Egypt, about Cairo, were the 42nd Division, some Yeomanry and the Australian and New Zealand formations training and equipping. Altogether, the troops in Egypt amounted to about 70,000 men. The force was short in artillery, and so relied on the Royal Navy and French war vessels to supplement its gun-fire from the Canal. Major-General A. Wilson put his headquarters at Ismailia and had an advanced base at Zagazig, whence the single line railway served the Suez Canal.

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The Suez Canal Defences were organized into four sections. The principal defended posts on the east bank were :—

1st Section : El Shatt, Kubri, Geneffe ;
2nd Section : Deversoir, Serapeum ;
3rd Section : Ferry Post, Ferdan, Ballah ;
4th Section : Kantara, Port Said Salt Works.

The 10th Indian Division, and part of the 11th, furnished troops for these posts. The remainder of the 11th Division, and the Imperial Service Cavalry Brigade, were retained in reserve at Moascar, near Ismailia. Heavy bridges were provided at Kubri and Kantara. Light foot-bridges and ferries were prepared for most of the other posts. Water transport was in great demand, and steam and motor boats were only too scarce at first. The lack of a road along the Suez Canal was much felt ; and this was not provided until nearly two years later.

Three days after the Turks had declared war 14 transports left India for Suez with the first instalment of the 12 battalions, three cavalry regiments, and Bikaneer Camel Corps, which had been put under orders for Egypt a fortnight earlier.

Egypt immediately evacuated El Arish and Nekl according to plan. The Turks crossed the frontier, and by 15th November they were considered to have 5,000 infantry and 3,000 Arab auxiliaries in El Arish. Four days later they reconnoitred El Abd, and on 20th November attacked and drove back a strong patrol of Egyptian Coastguards at Bir el Nus (half-way between Abd and Kantara). Constantinople announced this skirmish as the occupation of the Suez Canal. Early in December the inundation ordered by General Sir John Maxwell—between Port Said and Kantara had taken effect and greatly reduced the front to be patrolled.

Troops of the Turkish Expedition had entrained at Damascus on 23rd December. They proceeded *via* Afule, whence they marched to Jerusalem, and on through Beersheba, Auja, and El Arish. The British were getting fairly good information of their progress. On 13th January, the Turks were reported at Auja and Kossaima, and said to be increasing at El Arish. (See *Plate* II.).

On 15th January, the R.F.C. located 700 troops at El Abd, and parties on the Bir Murr and Moiya Harab roads.

On 24th January, 200 Turks appeared at Dueidar. Next day the post at Hill 70, eight miles out from Kantara, was attacked.

Jemal Pasha now issued his hortative to his troops :—

> " Warriors ! Behind you lie the vast deserts ; before you is the craven enemy; behind him the rich land of Egypt, which is waiting impatiently for you. If you falter, death will overtake you. Before you Paradise lies."

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The Turkish advance was now in full swing. Warships took post on 26th January, and Cairo was asked for an Australian Brigade. The intelligence reports of 26th January showed 5,400 Turks at various wells some 25 miles from the Canal. Next day, these numbers had swelled to 9,400 men, and some had come on closer. On 27th January, Kubri, seven miles off Suez, was raided.

It will be observed, that the raid attacks were made on the left and right while, actually, the main attacking force was assembling against the centre.

On 28th January, Kantara again was attacked; and a new camp appeared at Bir Habeita, eight miles east of Deversoir.

The camps continued to grow; but shipping went on through the Canal by daylight undisturbed.

On 1st February, the British patrols were in touch with the enemy all day from Serapeum to Ferdan, about 20 miles of front.

The situation on 2nd February was :—

5,000 Turkish infantry and guns east of Serapeum;
5,000 Turkish infantry and guns outside Ferry Post;
2,000 Turkish infantry and guns close to Kantara.

General Wilson reinforced behind Ferry Post with a battalion, and Cairo was asked for two more battalions and some Yeomanry, and also sent up a mountain battery from the Egyptian Army.

The Turks moved to the attack on the night of 2nd–3rd February. They sniped at Kubri and Ferdan, and made a feeble attack on Kantara defences. But, under cover of artillery and infantry fire, they brought their pontoons to the Suez Canal between Serapeum and Tussum. (See *Plate* III.).

Their attempt to cross was broken up by fire action, and by the armed launches on the canal. Actually, three pontoons got across, but all the Turks in them were killed or captured. At 0930 hours on 3rd February, the Turks brought up fresh troops against Serapeum, and again tried to force a crossing. Traffic in the canal was suspended. The shipping anchored in Lake Timsah came under artillery fire. The battleships *Ocean* and *Swiftsure* were moved to Deversoir and Tussum respectively.

At 1330 hours, the Turks drew off, leaving about 60 dead and 300 prisoners with the defenders. Covered by weak rearguards, the enemy began to retreat by the routes over which he had come.

On 4th February the Imperial Service Cavalry Brigade were crossed over at Ferry Post, and reconnoitred the enemy; they captured a small convoy, but did not engage the enemy closely. The night 4th–5th February was quiet: the whole canal was clear of Turks. On 5th February, the R.F.C. reported enemy columns retiring along all roads. The Suez Canal was re-opened by day for ship traffic; and night traffic was resumed a week later.

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The Turkish advance was boldly conceived, and well executed. Although it did not achieve its prime object of raising revolt in Egypt and blocking the Canal, it had a great effect. The demonstration of the possibility of bringing so large a force as 12,000 men of all arms across the Sinai Desert so impressed the authorities that the next time the canal was threatened nearly 400,000 troops were massed in Egypt. Moreover, the event showed that defending Egypt, and defending the Suez Canal, are not synonymous. The shipping in the canal is obstructed, unless the canal is defended from further east than its own banks.

The Turkish effort deserves admiration. To bring 12,000 or 15,000 men, artillery and pontoon train across 140 miles of desert was creditable; to assault a front defended potentially by 70,000 men, and the heavy metal of ships' armament, was audacious; to depart again with artillery and baggage intact, and a loss of not 10 per cent. of infantry was clear gain and left the defenders little to boast of. The Turks gave out that the attack was merely a reconnaissance raid, the precursor of a real descent in force. A German account published later declared that the Suez Canal was bridged, five battalions got across, and, but for the bulk of the attackers missing their way in a sand storm which enabled a cruiser to come up and sink the bridge, the invasion of Egypt would have been accomplished!

Among the features of these first four months of war in Egypt and Sinai, the most prominent were:—

(*a*) The general unpreparedness for war;
(*b*) Scanty knowledge of the water resources and routes of the Northern and Sinai Deserts;
(*c*) Lack of appreciation of the extent to which a descent on Egypt from east or west was practicable.

The attack on the Suez Canal was met by purely passive defence. There was no intention of or preparation for either counter-attack or pursuit. Although the Imperial Cavalry Brigade crossed the Suez Canal after the Turkish attack had failed, it merely watched the retreating enemy and returned to its camps. The moral effect of this inaction was that the Turk, although he failed, felt unbeaten, and he returned to attack again with greater forces 18 months later. Lack of transport has been urged in excuse for this. But Egypt and the Sudan employed normally—and ultimately furnished the army with—thousands of camels and donkeys. And the Yeomanry and the Overseas troops in Cairo were admirable material at hand for extemporizing Camelry.

(*To be continued.*)

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*THE BATHING PROBLEM IN UPPER SILESIA.**

(Communicated by the Chief Engineer, British Army of the Rhine.)

THE British Upper Silesian Force concentrated at Oppeln early in June, 1921. By the end of that month it was extended on a frontage of some twenty-five miles to a depth of twelve miles.

For the most part, the troops found themselves distributed in small posts and detachments occupying villages of a very primitive nature.

The local water supply consisted usually of a few shallow wells; of sanitary arrangements there were practically none. As a result, many types of disease were prevalent; the possibility of an influx of refugees from the Russian famine added to the risk, serious enough in normal times.

The preservation of the health of the Force at once became a matter of prime importance, and the provision of suitable hot bathing accommodation an early essential.

It was apparent from the wide areas to be covered and from the constant changes in the disposition of the troops that some mobile type of bath would be required.

To meet these contingencies, the idea of a bath lorry and a bath train was evolved, the latter to bath units within reach of the railway, the former for the more isolated posts.

By arrangement with the D.A.D.R.T. the construction of both was carried out by the German railway authorities in their workshops at Oppeln.

Since August, both have been in continuous use, and have been of inestimable value.

Winter conditions later on restricted the use of the lorry, but the train, fitted with stoves and corridor connections, still carried out its weekly programme.

The accompanying plates need little explanation.

* Several interesting photographs, showing the bath lorry rigged up for bathing in a large building (in the summer months it was rigged in the open), and the interior accommodation of the bathing and dressing vans of the bath train, were also received, but the Editor regrets that they were found unsuitable for reproduction, and had to be omitted.

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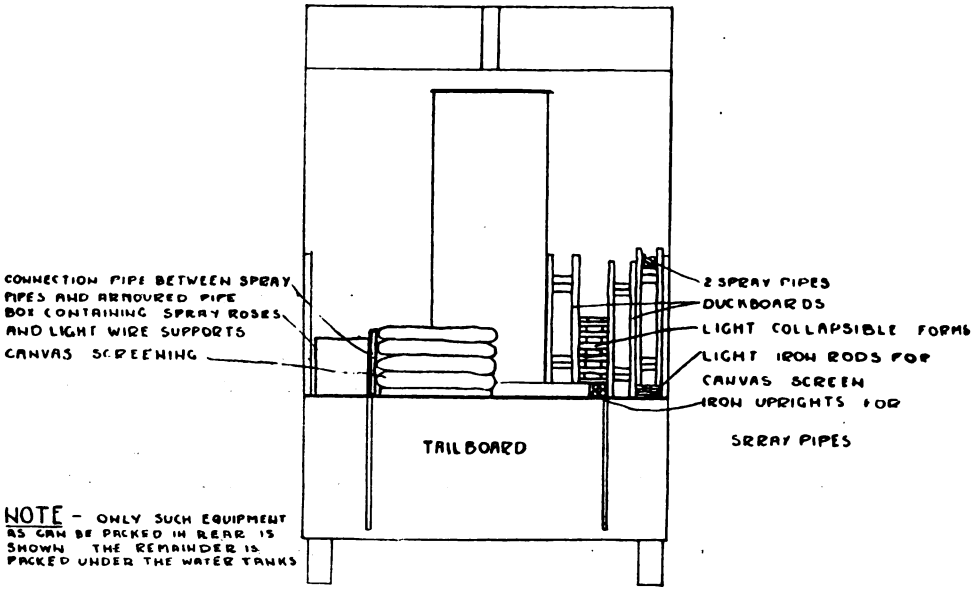
The following particulars may be of interest :—

	Bath lorry.	*Bath train.*
Water supply ...	By hand pump or lorry from nearest available service.	From locomotive.
Method of heating water	Central flue boiler.	Hot water from engine.
Bathing capacity ...	40 men per hour.	120 men per hour.
Time required to set up, heat water, and commence bathing	One hour.	10 minutes.
Maintenance personnel	One M.T. Driver, one Sapper	One R.A.M.C., one Sapper, attendants and German railway personnel.


CONNECTION PIPE BETWEEN SPRAY PIPES AND ARMOURED PIPE BOX CONTAINING SPRAY ROSES AND LIGHT WIRE SUPPORTS
CANVAS SCREENING
2 SPRAY PIPES
DUCKBOARDS
LIGHT COLLAPSIBLE FORMS
LIGHT IRON RODS FOR CANVAS SCREEN
IRON UPRIGHTS FOR SPRAY PIPES
TAILBOARD
NOTE - ONLY SUCH EQUIPMENT AS CAN BE PACKED IN REAR IS SHOWN THE REMAINDER IS PACKED UNDER THE WATER TANKS

BATH LORRY.—SKETCH ELEVATION SHOWING LORRY PACKED FOR TRAVELLING.

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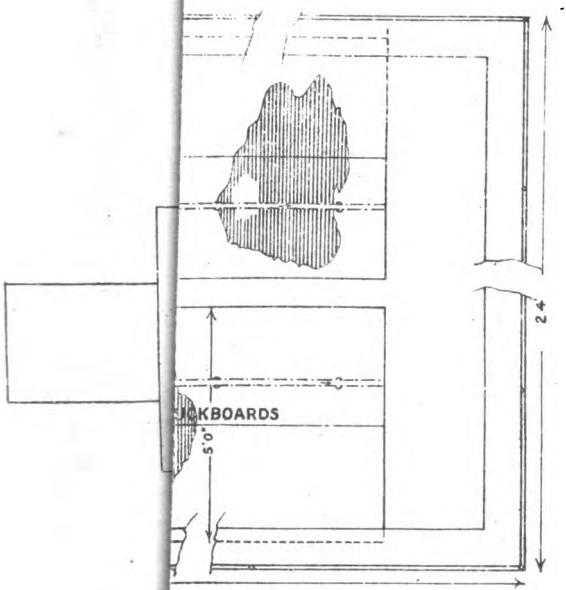
PLATE



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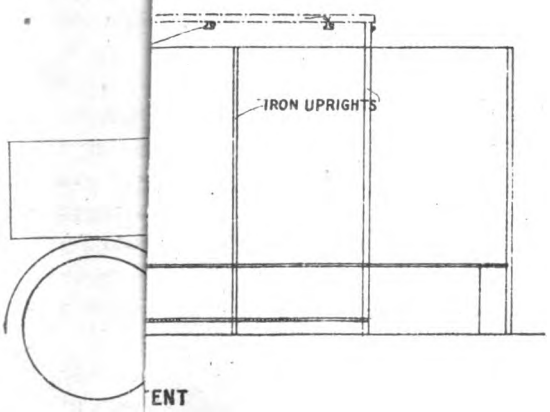

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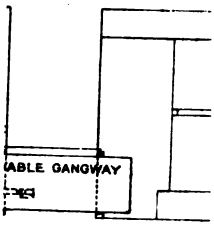

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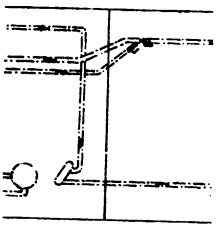
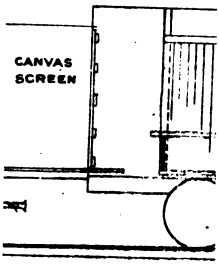


SHOWING WATER



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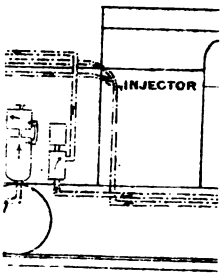

VATION.

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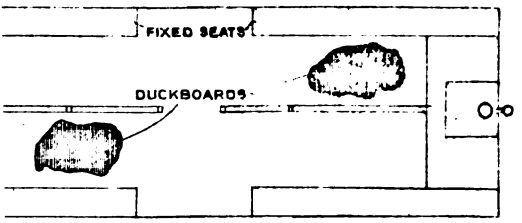
UPPLY.

PLATE



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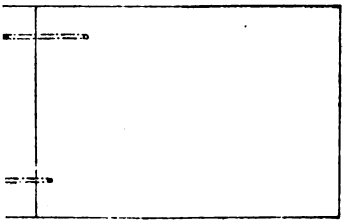
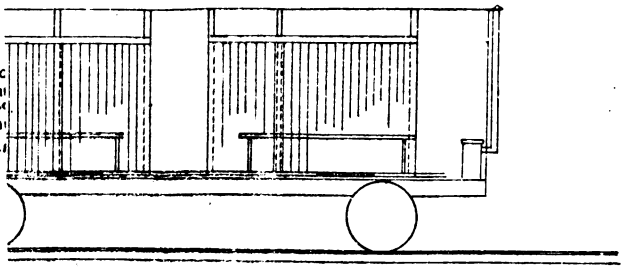
DRESSING VAN.



TRAIN CONSISTS
OF 2 SUCH UNITS,
i.e.
2 BATH VANS.
2 DRESSING VANS.
1 ENGINE.
1 GUARD VAN.

SUPPLY.



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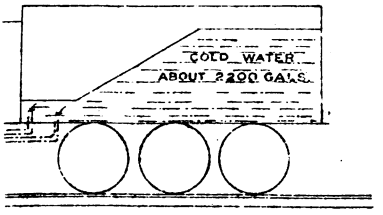

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THE SUPPLY OF BULK STORES IN WAR.

By LIEUT.-COLONEL and BT.-COLONEL J. W. S. SEWELL, C.M.G., R.E

INTRODUCTORY.

1. The historian of the work of the R.E. in the War of 1914–1918, in his "Supply of Engineer Stores and Equipment" has produced a successful, if brief, record of the growth of the organization developed at home for the acquisition and shipment of engineer stores to various theatres of war. The last few pages are devoted to a sufficiently accurate record of the work of the organization in one of the theatres of war, *viz.*, France, created to collect, hold and distribute engineer stores.

This history only carried the reader as far as June, 1918, at which period the Store Branch of the Director of Works organization was reformed into a Directorate under the Q.M.G.

The subsequent months included a period of mobile war, which presented different problems from those arising in the supply of stores to armies stabilized in one position.

The historian very truly observes "few subjects need studying with more careful regard to attendant circumstances."

2. The object of this article is to deduce from the cold facts recorded, and from the records of the Stores Service in France, lessons which may serve to guide officers called on at any future date to organize a service for the supply of engineer stores in a theatre of war.

It is fully recognized that the conditions which prevailed in France from 1915 to September, 1918, were those pertaining to one type of war only, *viz.*, siege or trench warfare; that such conditions are not those for which a modern army is normally trained and organized; and that the arrangements requisite for supply of engineer stores during a long period of stabilization are widely diverse from those required to supply stores to an army "on the move."

Nevertheless, the study of the history of the British Army, and of the national organization, or rather of the lack of any such organization for war, may justify the conclusion that in any great continental war in which this country is engaged the British Army will probably again be required to act on the defensive as a covering force behind which the national resources can slowly be mobilized.

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There would, therefore, appear to be strong arguments that we should be prepared for a considerable period of "trench-warfare," and that such preparations should include, if not an active organization, at any rate a considered plan for the supply of engineer stores in great bulk to stabilized armies.

Moreover, it will be quite unsound to attempt to base such an organization upon any principles laid down by continental powers for the guidance of their army administrations.

In such countries supply to their armies can be organized in parallel lines of supply, running from areas of the country to the various formations. Supplies, however, for a British Army must inevitably pass through a bottle-neck in crossing the sea and then arrive at one or more bases from which lines of supply will radiate to the various armies. In consequence, the volume of supply is eventually controlled by considerations of transport facilities.

The principal considerations before a supply service are :—

(i) What will the Army require ?
(ii) How can it be obtained ?
(iii) How can the required quantities be transported to the critical point at the critical moment ?

Of these the third will always be that which causes the gravest anxiety.

3. In order to envisage properly the arrangements required, it is necessary first to consider the conditions imposed. In the following four paragraphs are enumerated, in broad outline only, the conditions which prevailed in France, as regards the existing lines of supply. Paragraphs 8 and 9 record a few general statistics of engineering stores supplied in France, gathered from the records of the Stores Branch.

TRANSPORT CONDITIONS IN FRANCE.

4. For an army reaching from north of Ypres to Albert and the Somme, there were in 1915 the following possible lines of supply :—

(i) Dunkirk—Hazebroucq } Lille.
Calais—Hazebroucq }
(With a branch line Hazebroucq—Ypres).
(ii) Calais—Aire—Bethune.
(iii) (Single railway) Etaples—Arras.
(iv) Abancourt—Amiens—Albert ; Abancourt being connected to Havre, Rouen and Dieppe.

The principal lateral line connecting these lines of supply was the main line :—

Amiens—Abbeville—Etaples, Boulogne—Calais, with a single-line extension from Calais to Dunkirk. This was the only line available

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for the transfer of troops from flank to flank, for the movement of stores obtained in France, and for cross-movements, between northern and southern depôts.

The line Bethune—St. Pol—Amiens was a supply line, rather than a lateral.

The incidence of this remark will be inferred from the following facts :—

(i) The bulk of the timber—constituting more than 50 per cent. of the bulk of engineer stores—was obtained from areas south of the Somme.

(ii) The provision arrangements made in the United Kingdom involved considerable inter-depôt movements in order to carry sets of stores.

(iii) A great offensive necessitated the use of the store reserves from both northern and southern depôts on one sector of the front.

Of the rail lines of supply mentioned above it may be observed that :—

(*a*) The Calais—Dunkirk line was doubled in the winter of 1916–17.

(*b*) The Etaples—Arras line was doubled in the winter of 1916–17, the work being completed only just in time for the battle of Vimy Ridge.

(*c*) A double line direct from Dunkirk to Ypres salient was constructed in 1917.

(*d*) Finally, in the summer of 1918, the Etaples—Abbeville line was quadrupled but not opened, and a new line was opened leading up to the southern flank of the Third Army front.

5. The following elementary transportation statistics may be worthy of note :—

(*a*) For engineer stores, 1,000 tons required three trains.

(*b*) The whole of the above lines, except the Hazebroucq—Ypres line were operated by the French railway company throughout the war.

(*c*) Two hundred trains daily was the maximum number of trains which it was considered feasible to operate for the B.E.F. on the lines concerned, with reasonable efficiency. These included personnel and ambulance trains and any inter-depôt trains. Even quiet periods demanded at least one ambulance train and one leave train per army per diem. For rough calculations the whole army was usually assumed to be equivalent to 60 divisions, each of which required one food train per diem.

The average number of trains of engineer stores required per diem, including supply of L. of C., was twelve.

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(*d*) Engineer stores ex-U.K. represented about five to six per cent. of the volume of traffic, but probably not in excess of three per cent. of the value.

(*e*) When estimating transport possibilities, it must be borne in mind that what is required is maximum momentum, which obviously determines the quantity delivered at a given spot in a given period. It is futile to double the number of trains started, if that results in halving the average speed over the line.

During the battle of Passchendaele, supply services, etc., were actually starting at one period about 270 trains daily, but it was found that this reacted deleteriously on the tonnage actually received daily at the front.

(*f*) A single line of rail is only "good for" about 12 trains per diem each way.

6. It is instructive to recall the discovery and elimination throughout the war of the various "transportation limits." Unfortunately a "bottle-neck" is naturally discovered, like a weak link in a chain, by a test load; its elimination usually spells construction with attendant train-loads of heavy material.

The Q.M.G. staffs have then to decide whether to reduce supply trains by *m* daily, in order to obtain an increase of *n* trains daily at a later date, where *n* is, of course, hypothesized as greater than *m*. The answer to this conundrum must normally be "a bird in the hand is worth two in the bush."

Chronologically the limitation was discovered as follows:—

1915–6.—Slow discharge of ships in French ports resulted in the tonnage landed from the available ship tonnage imposing the limit on supply. This was met by development of wharves, and large increases to the number of cranes installed in peace.

This was followed in 1916 by the discovery that narrow rail exits at Havre and Dunkirk had insufficient capacity to clear away stores as fast as they were discharged.

This was met at Havre by the formation of the Soquence Canal Depôt (later to be one of our bugbears) and construction of a new line to Dunkirk Harbour from Coudekerque rail depôt.

1916–7.—The congestion resulting from establishment of store depôts (food and ordnance) on dock wharves was eliminated by the move out of such depôts from the ports. Next, supply lines were doubled and new lines constructed, necessitating lifting and transferring to France whole branch lines from U.K.

Then the limit was imposed by available rolling stock. This was met by importation of rolling stock in large quantities, and construction of repair shops.

These were only some of the major operations which gradually developed transportation efficiency, until about the summer of 1918

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transportation had arrived at a stage when in effect as much stores could be carried as the armies really required, until, of course, the advance began.

7. The foregoing remarks are made in no spirit of criticism of the work of transportation officers. Of our relations with them stores officers have only the happiest remembrances of their willing, even self-sacrificing, readiness to co-operate and assist in every manner within their power, and often beyond their authority; of their tireless and incessant struggle to overcome the numerous obstacles; and of the efficiency eventually attained in the development of transportation to the fighting armies. But it does not appear fully to be realized by the fighting arms how intimately supply is interlocked with transportation. This somewhat long digression is intended as an attempt to present, from the aspect of a layman, a bird's-eye view of the transport problem, in order that it may be realized that whatever organization be adopted for a branch to supply engineer stores, it is essential to efficiency that it should take a form which allows for the closest and quickest co-ordination with the transport branches.

I have only dealt with sea and rail transport, but in 1918 it was beginning to appear that a stage had been reached when the limit was the rate at which distribution by road could be effected from railhead, a matter which will subsequently be considered.

Principal Engineer Store Statistics.

8. A study of the tables annexed to the History of *The Supply of Engineer Stores and Equipment* will reveal the following principal statistics for engineer stores:—

	Tons.
Average monthly supply to formations ...	110,000
Maximum „ „ „ ...	140,000

Of this 110,000 tons more than half consisted of raw timber, 90 per cent. of which was supplied by the Directorate of Forestry *ex* French forests; about one-third only of the gross receipts was imported from the U.K. The remaining one-sixth consisted principally of timber articles manufactured in base workshops.

Summarizing, it may be said that trench war requirements involved the supply per division per mensem of:—

	Tons.
Timber	1,000
General R.E. stores	700
Articles manufactured at bases	300
Aggregate ...	2,000

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9. To complete the collection of a few principal facts, the following table of rough values in 1918 may be of interest in these days of cost accountancy :—

	Value per ton.
(i) Engineer stores—Timber	£15
General stores	£25
(ii) Ordnance stores—General	£50 to £100
Clothing	£300
Ammunition	£200
(iii) Foodstuffs	£70

Based on these tonnage values and the known weekly importation of various classes of stores, it has been very roughly estimated that the total average daily consumption by B.E.F. of supplies and stores of all descriptions, including equipment and ammunition, amounted to about £2,500,000, of which engineer stores represented about £80,000.

The aggregate cost of the personnel engaged directly or indirectly in discharging, storing and handling these stores at bases cannot have fallen far short of £250,000 per diem. These figures, which, it is believed, are not exaggerated, are given with a view to emphasizing the necessity for the most efficient supply organization. An economy of only five per cent. on these figures represents £50,000,000 per annum.

Engineer Stores as a Portion of Bulk Stores.

10. The historian has been at some labour, in his introductory remarks, to attempt a definition of engineer stores. A wider view would appear to be justifiable. Thus the stores required for an army may be classified as :—

(i) Food supplies.
(ii) Arms and ammunition—including guns, gun-carriages and "tanks."
(iii) Vehicles of every description (except gun-carriages), including rolling stock.
(iv) Equipment.
(v) Bulk stores.
(vi) Animals.

The fundamental distinction between "bulk stores" and "equipment" is that bulk stores can and must be forwarded in train loads to various "sectors" of the front, or "areas" of L. of C. Equipment comprises those stores which require to be sent to a specific consignee unit on a detailed demand.

It must be realized that these two classes of supply demand entirely different methods of storage, accountancy, and above all, of transportation.

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Bulk stores are loaded by the truck-load. A scientifically laid-out depôt of bulk stores will, therefore, allow for loading any category of stores into a truck with the minimum of rail movement on the one hand and of "carry" on the other.

Equipment is loaded by assigning one truck (or covered van) per consignee unit. Long carries in a depôt are unavoidable, but the aggregate weight so carried is not great compared to bulk stores.

Again, as regards accountancy, statistics for equipment are designed to show the average rate of consumption of each specific store per, say, division which the depôt has to feed. This enables a forecast to be made of the next few months' requirements *ex* U.K.

Bulk stores, on the other hand, are in general supplied perforce on a "ration" basis, and statistics must be framed to record the quantity issued up to the ration allowed per, say, Corps.

Supply of equipment then means normally dispatch of one or two trucks to each Division daily. These trucks are normally attached to the Division's food-supply train: for this purpose the equipment depôt must be adjacent to the food depôt.

Supply of bulk stores involves the dispatch of complete train-loads to one or two destinations for each train, normally not the supply railheads, but stations further to the rear.

Bulk supply should, therefore, include the supply of such "vocabulary stores" as barbed wire, sandbags, screwposts, etc. In fact, it smoothed working when the Engineering Stores Directorate took on such stores at the ship's side at French ports. Bulk stores might with advantage also include such bulk supplies as blankets and tents, and should certainly include railway construction material.

A prospective advantage to be obtained during mobile war will be referred to later. Whatever be the reader's opinion, however, on the matter, it must be accepted as a transportation axiom that engineer stores must proceed in *complete train loads*; it will generally be accepted that they should comprise all stores used in bulk by the R.E.

11. It is possibly necessary to enunciate the processes involved in the supply of engineer stores in order that a true perspective may be obtained, before any visualization of the necessary organization can be attempted. These processes are:—

(i) Prevision.
(ii) Provision.
(iii) Sea transport.
(iv) Storeholding and sorting.
(v) Distribution.
(vi) Rail transport.
(vii) Reception and distribution in army zones.

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No attempt will be made in this article to view these processes from any other aspect than that of the officer in the theatre of war, but it is now proposed to consider each of these processes *seriatim* and to enunciate the lessons to be inculcated so far as the trench war period in France was concerned. It must be borne in mind that the conditions were of a special nature and that, in consequence, it will not be safe to draw conclusions of too general a nature.

12. *Prevision.*—As regards field stores. This is a function—and no unimportant function—of the E.-in-C. Upon his forecast of the probable requirements of the field engineers, six months ahead, depends the whole efficiency of supply. It was found, even when the manufacturing output of the U.K. was strictly organized, that it took about four months for the first arrival of a new pattern store and quite six months before a steady flow was ensured. In the occasional event of a clamour from armies for some special store which has not been foreseen, or for abnormal quantities of a normal store, it is almost invariably the case that the demand has died before supply has developed. We were left at the Armistice with some considerable stocks which were obtained as a result of army pressure, but often not used at all, or absorbed only to a very limited extent.

The E.-in-C. has to foresee both types and quantities which will be required. He has also to decide on standard patterns, usually a compromise between the different opinions of several armies as to the best type, modified by consideration of the alterations required to obtain maximum supply. This modification is important and very essential: especially in details of such trench stores as "A" frames, trench boards, etc., modifications which did not affect strength but enabled "standard" sizes of timber to be used, resulted in most important increases of the output. Critical study of the country behind the enemy's lines was essential to enable a forecast to be made of the bridges, which would be required, and of the water supply plant essential to certain areas.

The R.E. generally do not sufficiently appreciate the extraordinary foresight which was displayed by the E.-in-C.'s staff in this respect. As one example alone, it may be noted that the bridges used in the advance of 1918 had, under E.-in-C.'s orders, been gradually accumulated for three years; whilst 1,200 steel cubes, manufactured in 1916, were absorbed suddenly in the 100 days' battle of 1918 at a rate which caused grave anxiety for a time; but they lasted out.

The three-year-old prophecy, in fact, was precisely justified by events.

To such prescience the whole stores branch also owes a deep debt of gratitude; for inevitably a shortage must have been blamed to their account.

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13. *Provision.*—Once requirements have, however, been predicted, the compilation of indents is *prima facie* easy, but close co-operation with the home authorities is very essential. Doubtless owing to reluctance to worry overworked men in the theatre of war, the provision branches at home did not always confide to us their difficulties. When they did it was often possible to compromise. For example, in 1918 the ration of steel for engineer stores in France was about 20,000 tons, which did not meet the demands of E.-in-C. and D.W. The situation was met by reduction of the army demand for corrugated iron and acceptance of shell-discarded steel for some other stores (*e.g.*, screwposts). Again, the situation demanded minimum use of sea freight; it has already been pointed out that only one-third of the whole tonnage of engineer stores was imported. It will inevitably be necessary in all wars to develop to the uttermost the resources of the theatre of war: it may be hoped that such development will definitely be assigned as a function of a glorified Director of Works—let us say a D.G. Engineer Services. The total supply of timber from French forests attained to a figure of about 100,000 tons per mensem for R.E. and railways.

The maximum quarry output is not known to me. Both these development branches were originated by D.W.

Again, brick and concrete block factories were developed to a considerable extent.

The obvious lesson is to study beforehand the resources of the probable theatre of war, and in due course to take over to it the requisite staff of experts.

14. If a digression may be allowed at this point, it may be observed that peace and small war practice have inculcated on the R.E. the geographical organization by which a C.R.E. takes control of all R.E. services in his area, with the aid of a few junior experts. But in an extensive campaign a time will arrive when it may be advisable to scrap this economic organization for a generic organization in which experts in one branch of engineering are formed into a directorate or sub-directorate controlling, over the whole theatre outside the zone of the armies, the special operations assigned to their branch. Primarily this involves a large increase of officers, but:—Firstly, it will probably result in intensive work;

Secondly, it will, if due control be exercised, result in an economy of "labour," owing to the greater and more specialized supervision;

Thirdly, it is a system by which maximum results can be obtained from Civil Engineers, who are normally specialists in some one branch. This makes no difference in the function allotted to a Director of Works, but means that instead of directing C.R.E.'s he will command Directors of Engineer Services.

15. Under the head of "Provision" must be considered the subject of base factories. As is, no doubt, well known, shipping

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tonnage is a matter of cubic feet, not of deadweight tons. My own general impression of engineer stores was that on an average it required about 2½ shipping tons to make up one ton deadweight. It is therefore very necessary to use every endeavour to reduce bulk to a minimum. Great economy can obviously be effected if timber trench stores can be manufactured from raw material in the theatre of war.

The only question is at what site in the theatre of war should this conversion take place. I have no quarrel with Army or Corps Workshops in principle; they are necessary for certain purposes, but I submit that they should be kept mobile, that normally they should be restricted to jobbing repair work and the manufacture of a few special "jims" peculiar to their own locality, and that iron-working tools should be rigidly restricted to those essential for rapid repairs to R.E. machinery. The objection to allowing Army shops to develop into factories is that they tend to immobilize field forces, absorb fighting men of category "A," and then, owing to dissipation of effort, do not, with the same amount of plant, produce in the aggregate the results that can be obtained from concentrated factories in the L. of C. in which prisoners of war, unfit men, women, and even children—in fact, the "useless mouths"—can be employed.

As a result of the retreat of 1918 the E.-in-C. decided to concentrate manufacture at the bases Calais and Abancourt. The reader is referred to Table L on page 96 of the History and is invited to consider whether this decision was justified by the result.

Going to the other extreme, personally I remain an unconverted believer in supplying a Divisional C.R.E. with a small circular saw to be driven from a lorry flywheel. But this is a personal heresy.

16. Another source of provision is local purchase in the theatre of war—a subject that requires some control. Obviously C.E.'s must have power to acquire local stores, but if they continue to purchase for several years in a limited area, it is equally obvious that a very undesirable situation will be created. In France, in 1915, local merchants continued to import from Paris or elsewhere to the Army zone in order to sell to the local C.E. or C.R.E. in base areas. This entailed competitive buying with the resultant forcing up of prices, profiteering, by local merchants at the expense of the British public; and finally traffic of civil stores over railways whose last ounce of accommodation was required for the supply to the Armies of troops, ammunition and such necessaries. In effect, it amounts to a circumvention of the orders of the C.-in-C. as to priority of supply.

17. *Sea Transport.*—This concerns the R.E. in several matters. Firstly it is a R.E. service to develop the ports so that maximum duty may be obtained. It may be—often will be—necessary to construct wharves: whilst it may be taken for granted that many

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cranes will be required in order to produce maximum discharge. Generally, the best type of crane will be found to be the Port of London type, three or five tons, carried on a travelling gantry which strides the rail sidings. One powerful crane will be essential which can lift 30 or 40 tons. This will be a fixed crane ; for the few lifts of this nature required, ships will shift their berth to come under the crane. Extra wharf sidings and cross-overs are sure to be required and, usually, a development of the connections between the wharf sidings and the railway sorting sidings outside the Port. The main objective is to reduce the time of discharge to a minimum.

18. Reference has already been made to the necessity for reducing imports to a minimum by development of the resources of the theatre of war ; also to the necessity for reducing bulk by conversion of imported raw material to manufactured articles in the theatre of war.

19. Beyond this there is a distinct necessity for greater consideration than existed in the European War, between stores officers in the theatre of war and provision branches at home in dispatch of cargoes as and when required. In France we were assured that it was not feasible to create in England a receiving depôt to accept stores as manufactured and to dispatch to the theatre of war as indented. That being the case, it was necessary to accept the disadvantages. It may be as well, however, to enumerate these, in order that in future wars the advantages to the home authorities may be fully weighted with the disadvantages to the Expeditionary Force.

The system which prevailed during the War was dispatch direct from factories at home to base depôts in France. At the best this involves holding enormous stocks in the theatre of war, for manufacture must proceed steadily throughout the year, whilst demands are largely seasonal. For example, Nissen huts poured in steadily throughout the year with the result that we would be holding 25,000 or more ready to send up in October, November and December. This involves huge depôts in the theatre of war with attendant risks from enemy aircraft and *saboteurs ;* it also necessitates an extensive personnel, which is naturally more costly in the theatre of war than at home depôts.

Directors in France were constantly pressed to reduce " reserves " ; we unanimously agreed that we would cut our reserves to little over the amount consumed in the period necessary to fulfil a shipping indent. Nevertheless, I found it impossible to hold, under the prevailing conditions of shipment, less than 350,000 tons or three months' supply measured by tonnage. Nor, from our point of view, was this the worst. Owing to the existence of several base ports and two main base depôts, the home system of shipment, from the port nearest to the factory, and of shipment as manufactured,

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it constantly occurred that a whole cargo of, say, Nissen steel work would arrive at Havre, whilst corresponding wood work arrived at Dunkirk. Also "sets" of machinery became separated in a similar manner. The requisite redistribution and resorting in France was not only a great strain on our organization, but involved further traffic on the one congested lateral railway between north and south.

We desired the existence of a central R.E. store depôt in England which would collect all stores from factories, make them up into sets and hold in store until they were required in France. Had this been feasible, far smaller depôts in France would have been possible, fewer personnel and less rail traffic.

20. When the number of ships (and their tonnage) which can be allotted for carrying stores to the theatre of war has been determined by the Admiralty, and when the ports have been developed so as to obtain the quickest possible "turn round" of those ships, it is even then almost axiomatic that the supply of stores may be placed in the following order of decreasing tonnage :—

(i) What the Army desires to receive.
(ii) What the provision branches can obtain.
(iii) What can be transported by sea.
(iv) What can be transported from bases to Armies.

(iii) and (iv) may change places at times, whilst for certain classes of stores (ii) is sometimes the limiting factor.

The C.-in-C. functioning through his Q.M.G. (who may delegate authority in this respect to an I.G.C.) has then to decide the tonnage to be allotted to each category of stores. Some of them must be reduced; the reduction will only touch food supplies in extreme cases. Similarly equipment can hardly be reduced, nor does it really bulk largely in the tonnage programmes.

For the comfort and morale of the troops, reduction of canteen tonnage will, if possible, be avoided. Consideration of the classes of stores enumerated in para. 10 will show that reductions must almost inevitably fall upon ammunition and bulk stores, with due regard to the relative importance at the moment of destroying the enemy and his morale, and of preserving our own troops and their morale. Reduction in the bulk supply of engineer stores must therefore be accepted by R.E. officers as due to the considered decision of the C.-in-C., and not to negligence or lack of sympathy on the part of supply services.

STOREHOLDING AND SORTING.

21. Upon this subject a volume by itself might well be written; it is, however, necessary to economize space. I will therefore only attempt to enunciate some of the main principles discovered by experience, and to give a few statistics which may guide officers in

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future. We may consider this subject under the following sub-heads :—

(*a*) Size of depôt.
(*b*) Site.
(*c*) Rail lay-out.
(*d*) Depôt lay-out.
(*e*) Operation of a depôt.
(*f*) Shops.
(*g*) Storeholding generally.

22. *Size of Depôt.*—In para. 9 an estimate has been given of the average requirements of engineer stores, including huts, per division per mensem, *viz.*, 2,000 tons, during trench warfare. This figure must be multiplied, of course, by the number of divisions to be supplied from the depôt projected; the resulting figure must again be multiplied by the number of months which is required for the fulfilment of a shipping indent. A shipping indent must not be confused with a provision indent.

A provision indent normally takes the form of an estimate of the stores required in the theatre of war by all services to be supplied (*e.g.*, E.-in-C., D.W., railways, etc.) during the next six months. Upon receipt of this indent the home services proceed to arrange a manufacture programme. A shipping indent is a definite indent for the shipment during a given month of named quantities of named stores, the total (ship) tonnage of which must not exceed the (ship) tonnage allocated by the Q.M.G.

In view of the fact that sudden developments at the front may involve rush demands for trench stores, bridges, or water supply stores, it is further necessary to add to the figure obtained as above a considerable percentage to cover reserves of such stores. Similarly a percentage must be added to allow for the collection throughout the year of huts ready to be rushed up when the Armies "go into winter quarters."

For example, for a depôt like Les Attaques we might proceed as follows :—

2,000 × 30 (divisions) × 2 (months to supply a shipping indent) = 120,000 tons.
Add 50% for reserves, etc. We must arrange to hold 180,000 tons.

Now, under the conditions of siting to be considered in the next paragraph, land is of small value as compared to the importance of reducing labour: it is therefore undesirable to stack too high. A good rule was found to be, "allow for all purposes one acre per 1,000 tons."

The Les Attaques depôt, including about 15 acres occupied by the

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factories, covered approximately 220 acres and normally held 160,000 to 180,000 tons. (See *Plan*).

23. *Site of a Depôt.*—It will readily be admitted by all concerned that it was by a dispensation of Providence rather than owing to any realization of the principles, which were later discovered to be involved, that the depôt at Les Attaques (except in one particular) was sited, in the autumn of 1915, exactly where it ought to have been.

The principles are :—

(i) A depôt must not be in a dock area, for free space is necessary to quick discharge of ships.

(ii) It must not be so far from the port that haulage from port to depôt involves the occupation of a main line " marche."

(iii) It must be beyond the rail-sorting station, into which pour a miscellaneous jumble of trucks loaded with every conceivable store ; in this sorting station trucks must be marshalled for their appropriate depôts.

(iv) If, as is very desirable, inland waterways are available, the depôt must be sited so as to permit of discharge from ship to barge, transit by barge to barge-discharging point and then allow room for trucks loaded *ex* barge to reach another sorting " triage " where they and trucks arriving by rail from the rail-sorting station may again be marshalled for delivery into the appropriate depôt sidings.

24. Having these principles in mind it may be instructive to note the points in which inexperience led us to make mistakes in the original siting of our depôts.

(i) The original Les Attaques Depôt was that portion between the St. Omer Canal and main railway line—it was too narrow and only permitted the existence of short dead-end railway spurs. The depôt was on top of the barge discharge quays. The principle enumerated in para. 23 (iv) was thus violated —and we suffered from that violation.

(ii) In the south the junction of the Havre—Rouen—Amiens line with the Dieppe—Amiens line gave cause for the siting of the Southern Depôt at Abancourt in violation of the principle enumerated in para. 23 (ii).

In consequence, it was often difficult to obtain transport for stores direct from ship to Abancourt ; overflow dumps were formed at Soquence (Havre) and at Querilly (on the south bank of the Seine at Rouen). Owing to railway difficulties it was then difficult to get the stores out of these overflow dumps and impossible to get them out as and when required. With the intensive traffic of 1918 it was, in fact, found necessary to regard the bulk stores in these depôts as " dead " stock.

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(iii) Had the work to be done again, it would probably be found better to form a large group of depôts on the Seine in the country between Rouen and Caudebec, to construct wharves on the north bank of the river and to double-track the Caudebec branch line.

25. The danger of air raids must be considered, but need not be exaggerated.

If possible two bases and two base depôts are advisable so that all our eggs may not be in one basket. Again, if feasible, bunching of different store depôts in one confined area should be avoided, as offering too big a target. It is, of course, very desirable to choose a base which is unlikely to fall within hostile shell-fire owing to the ebb and flow of war.

But the danger from aerial bombardment, even of the intensivity experienced by Calais, is almost negligible. Bulk store depôts appear to be practically indestructible. "Hun Dump" at Bapaume changed hands three times during the war without any dislocation of its stocks or even of its accounts, which still exist as a continuous narrative of transactions recorded in German and English. Important sheds of machinery or workshops are always a source of anxiety, but the "probabilities" are so largely against a hit that normal fire risks may be considered as far more serious.

Moreover, whilst opinions will vary, it appears possible that the true antidote to air raids was discovered in the last few months of the war, and may in future wars prove an effective deterrent.

26. *Rail Lay-out of Depôts.*—For a bulk store depôt, the rail lay-out of Les Attaques depôt south of the main railway line (R.E. grids) may be considered almost a type plan.

No scale has been attached to the *Plan*, but for guidance it may be stated that from Vampouille Farm to the branch road S.E. of Dimpre Farm is about one mile; from Vampouille Farm to Pont des Briques about 1,000 yds.

Trains from the Calais and Dunkirk docks arrived from the N.W. angle of the map in No. 4 *triage*; into this *triage* also poured trucks from the barge discharge point about 800 yds. N.W. of the Château de Vendroux.

In No. 4 *triage* the trucks were labelled at night for the appropriate sidings (Nos. 1 to 20) in the R.E. grids.

Railway experts on the Director of Engineer Stores staff considered that these sidings were too long—over 600 yds. effective length—and that a double lateral gathering line should have been constructed N.W. and S.E. across them.

The best distance between double sidings was found to be 150 ft. for general stores; 300 ft. for timber yards.

The sidings to the (timber) workshops should be noticed: one

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(on N. side) for receipt of timber from timber yards, one (S. side) for loading up manufactured articles and removal to stores yards.

A base depôt is not laid out in principle for delivery of stores to road convoys, but as such delivery may be required, it is as well to run a siding (*e.g.*, E. siding of international sidings) alongside a neighbouring road.

27. It is inevitable that both the site and the rail lay-out of a depôt will be governed largely by considerations of facility of rail construction. But transportation officers should bear in mind that in the event it is facility of railway operation which will make or mar efficiency of transportation. For example, No. 4 *triage* was for several months far too small (four lines), whilst Nos. 2 and 3 *triages* were unnecessarily large. As a result, until No. 4 was enlarged it was found impossible to work a truck through the depôts in less than five days. As an example of the difficulties of railway operations, which were insufficiently appreciated, it may be noted that it required normally 48 hours for the transit of a certain daily express truck from Fontinettes station (two miles from the depôt) to a named siding at Les Attaques.

28. It will be obvious that facilities of construction will demand for the site of a depôt any fen district which may be available. It is then essential that pipe culverts be laid in any ditches which sidings and *triages* may traverse.

If this is not done it is necessary to fill in the areas between sidings up to rail level—a most expensive and extravagant procedure which a small amount of foresight and delay in construction will render unnecessary.

29. *Depôt Lay-out.*—It must be assumed that officers concerned are gifted with sufficient prophetic insight to foresee the eventual size of the depôt. At any rate the following principles should be adopted; if the depôt increases beyond what has been foreseen, the necessary re-organization must be undertaken to relay-out the depôt in accordance with those principles.

(i) Alternate sidings with inflammable and non-inflammable stores.

(ii) On any given siding of inflammable stores, alternate stacks with wide "fire-breaks."

If space is becoming valuable, fill in the fire-breaks with non-inflammable stores. A chess-board lay-out is theoretically desirable, but it is not always very practicable, in so far as it is not consonant with the measures to be adopted for economy of labour, described in the next section.

(iii) "Store Groups" demand separate "yards" (*e.g.*, one siding for water supply stores.) Each yard will require a small office for tally cards and store accounts. Each group will normally require one or more closed sheds for small stores

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(*e.g.*, pipe accessories); and for stores which demand protection from the weather (*e.g.*, cement).

(iv) A 4-in. fire-ring main is very desirable, with hydrants and hoses. One central engine, of internal combustion type for choice, is necessary to force water into this main under pressure.

Fire-engines are of little use for the greater part of a depôt. A liberal supply of chemical extinguishers is essential to enable watchmen to scotch a fire at its inception.

(v) Factories: allow *ample* elbow room; it cannot be foreseen how much will be required. You are sure to underestimate and will not be far wrong if you allow for development to four times the size which you consider ample at first. Better waste land than be cramped later. If possible, choose a site which is open to the country at one end, so that sidings and shops may be extended.

Lay out so as to economize carry. A siding for the reception of selected timber from the timber yards will allow for stacks on the sidings, thence direct carriage to rip-saws; then to cross-cut saws; thence to nailing benches; thence to stacks alongside a removal siding; 400 to 450 ft., approximately, between arrival and departure sidings.

Do not attempt to combine a store yard and a factory—it is false economy; *i.e.*, do not put a factory in the timber yard, nor attempt to store manufactured articles in the factory yard. In this respect it is necessary to be deaf to the blandishments and to the growls of transportation officers.

(vi) As, however, one exception to this rule, it will be necessary to convert much timber to "scantlings." Les Attaques had to produce 1,000,000 F.R. of scantlings in a month at times. It is then economical to lay down some rip-saws (motor-driven and portable if possible) in the timber yards.

(vii) Generally the only rough advice that can be given is "think big and then multiply by four."

30. *Operation of a Depôt.*—The essence of efficient operation is to reduce to a minimum the number of transportation moves and the "carry" of stores, two conditions which are not, *prima facie*, compatible. By co-operation, however, this apparent incompatibility can be overcome.

(i) Loaded trucks *ex* ports (including barge ports), etc., arrive in the night, in a reception *triage*. The port has in the

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meantime advised, by telephone, truck numbers and general contents. Armed with these advices and "periscopes," a special staff must rapidly label these trucks for appropriate sidings.

(ii) The railway officers then have trucks shunted to the working sidings, including any empties required for loading. After the hour of commencing depôt work, say seven hours, no rail movement must occur in the working sidings until the dinner-hour; it will probably be necessary then to allow the railway officers 1½ hours for operation.

(iii) Of the trucks thus put into working sidings it will normally be possible to reconsign a fair percentage (10% to 20%) without off-loading. As regards the remainder, it is obviously very desirable to discharge straight to a stack alongside the truck, and similarly to load an empty from a stack alongside the truck—all without further truck movement (*prima facie* impossible). If any system is to be introduced into storage, as is of course essential, this result can only be obtained by "repeat" grouping of stores. This system is difficult to explain.

Essentially it consisted in the adoption of the following measures. Bulk stores were considered under two categories:—

(*a*) Those which required one or more sidings to themselves. For example, timber was classified generally in eight principal groups of sizes. Stacks were then laid out between two sidings, four deep between sidings; two such lines provided the eight groups.

The next group would be reversed.

Thus any group size could be loaded with a maximum of about 60 yds. of carry.

Water-pipes, again, were stocked in four principal sizes, 4 in., 2 in., 1½ in. and 1 in., and stacks of these sizes alternated along one siding.

Corrugated iron and steel shelters similarly required one siding each; cement about half a siding; steel joists, half a siding; bridges, two half sidings, etc. Sand-bags and barbed wire alternate well on one siding.

(*b*) Stores stocked in bulk which demanded only small frontages.

For these stores one of the store branch officers —Major Crossley, R.E.—invented what was subsequently known as the "repeat group system." Stores items, usually about 12 in number, were

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selected, *e.g.*, tanks, coir lewing, wire netting, wire weaving, etc.; proportionate quantities of each of these were formed into stacks about 50 ft. on the siding front, 75 ft. deep and 15 ft. to 25 ft. high, each store item forming a vertical column in the stack. One 600-yd. siding would contain about 15 to 18 of such stacks. As a result a truck arriving for discharge could be off-loaded to the stack opposite which it chanced to be placed by R.O.D.

Similarly an empty could be loaded from any stack opposite which it stood.

This system worked well, was obviously economical of labour and is strongly recommended for use under similar conditions.

(iv) During the depôt working hours, from 7 hours to 17 hours, with the exception of the dinner interval, the R.O.D. must avoid any rail movement on the depôt sidings. The dinner hour must be made long enough to enable the R.O.D. to move out loaded trucks, place more empties as required, and put in any trucks for discharge left over at 7 hours in the reception *triage*.

The work of making up and dispatching trains will be performed by R.O.D. from 17 hours to midnight: from that hour until 7 hours they will be receiving trucks from ports and shunting to sidings indicated, also in placing empties.

(v) During the afternoon, information and instructions will have been received as regards:—

(*a*) Number of trains allotted to depôt for dispatch by Q.M.G.

(*b*) Railheads vacant (from A.D.R.T.).

(*c*) Stores to be expected *ex* ports during the night.

The balance of the monthly ration of stores due to each railhead being also known, a conference of the depôt staff must be held after working hours to arrange the next day's programme of loading, reconsignments, and discharges, which in its turn may have to be modified by later information and instructions received up to midnight.

Instructions have to be issued to the labelling parties referred to in sub-para. (i).

(vi) It will be obvious that a flexible organization is essential, which will admit of rapid decisions being taken and the acceptance of considerable responsibility by subordinates on night duty.

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During periods when the front line was quiet, that is, when no major operations were in hand, it was found, under the conditions prevailing in France, that by arrangements with armies, the monthly ration "stores" for various Corps could be dispatched in "pack" trains with considerable advantage to all concerned. Acting on the railway principle that a minimum train must consist of 30 trucks and a maximum train of about 40 trucks, it was arranged that 30 trucks in each train should consist of a fixed consignment :—

So many trucks of timber.
So many of huts.
So many of corrugated iron.
So many of steel shelters, etc., etc., up to 30 trucks.

The balance up to 10 trucks consisted of stores specially or urgently required by one Corps.

Thus, if at the last moment, as frequently occurred, the railhead of "X" Corps was not cleared for receipt of a train, the 10 trucks special to "X" Corps could be cut off the train, and the 30 trucks remaining consigned as a minimum train to "Y" Corps.

Normally we could send one such train to each Corps every fourth or fifth day. This system had the advantage that a Corps received its ration in regular consignments, the quantity of each consignment being known beforehand.

31. *Shops*.—These must be considered under the sub-heads of :—

(*a*) Factories.

(*b*) Repair shops.

(i) As regards factories, manufacture in bulk at bases has been considered in para. 15.

The general principles of the lay-out have been dealt with in para. 29 (v).

The base factories for timber trench stores in France were required to convert each about 300 tons of timber daily. The imperative necessity will therefore be apparent of an organization which admits of a continuous flow of operations from raw material to completed article in a straight line, thus involving the minimum amount of carry. The proportion of rip-saws, cross-cut saws, and nailing-benches must also be calculated to avoid "bottle-necks." All cross movements must be avoided and subsidiary stores, such as nails, which will also run to tons per diem, must be fed in with the minimum of labour to the right point at the right moment. Organizing capacity is, in fact, of far greater importance than mechanical engineering science.

Moreover, a change of manufacture will involve alterations in the lay-out of plant which may cause a loss of a fortnight's

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output. It is, therefore, essential to foresee the total requirements over a long period (12 months, if possible), and to manufacture a monthly average which must be stocked in the depôt—not in the shop area—ready for heavy issues when the seasonal demand arises.

Any attempt to manufacture to indents is fatal to efficiency in the form of maximum output for a given plant and labour. For prisoners of war, task-work; and for civil labour, piece-work, are very desirable. The output on piece-work will be a good guide to the possibilities of task-work.

(ii) Similar principles control the manufacture of articles of iron work: as a general rule, however, base factories should only manufacture in ironwork new standard patterns required by the E.-in-C. until supply can be developed. The reasons for this limitation are sufficiently obvious.

(iii) Factories for construction of such timber and iron articles will obviously best be sited adjacent to a bulk store depôt which can supply the raw material and receive and store the output.

But the general rule for siting a factory must be to place it where the principal raw material can be obtained with the minimum transport.

(iv) Thus factories for concrete blocks for "pill-boxes" or other constructions, will obviously be sited at a gravel pit.

Brick factories will be sited adjacent to clay pits and, in so far as this may still leave an option, to such clay pits as may permit of coal being obtained with the minimum transport.

(v) It may be necessary to consider the manufacture of cement which will certainly be required in large quantities. As, however, a ton of coal is required for the manufacture of a ton of cement, no advantage will be obtained by manufacture in the theatre of war, unless coal can also be obtained and transported to the factory with less disadvantage to transport than is involved in importing cement from the U.K.

(vi) Before leaving the subject of factories, it may be worth while to consider what at first sight many will regard as a minor point; that is to say, what hours should be worked. On this matter, whilst holding no strong convictions, it appears to me from considerable experience, that the following factors should be given due weight.

(*a*) Engineers are not unanimous, but the weight of opinion appears to hold that machinery, like the animal creation, requires a daily rest.

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(*b*) It was a noticeable fact that many men who were certainly indifferent to the danger of the front line, who became further inured to its squalor, found almost unendurable the incessant noise. Now base depôts and factories, except for a few of the superior staff, must be run with prisoners of war and men unfit by reason of age or infirmity (often both). It always appeared to me that I could maintain their efficiency better if they could be ensured a few hours' quiet every day. Railway shunting is surprisingly quiet at anything over 100 yards' distance, provided the drivers can be induced to refrain from using their whistles.

(*c*) A night shift is never so efficient as a day shift, and is very liable to interruption by air raids.

Having in view these considerations, eventually a two-shift arrangement was adopted, which gave peace from the scream of high-speed saws and rest to the plant from 23 hours to 6 hours. I am still of opinion that we obtained maximum results from a given number of men, and probably from the plant installed, by working two shifts instead of three.

32. As regards repair shops—this has always been debatable ground and the matter has not yet been decided.

Metal repair shops are required in a theatre of war, supplementary to Army mobile repair shops, for the repair, *inter alia*, of :—

Armament.
Locos and rolling stock.
Mechanical transport.
Engineer plant.

Each of these operations will involve the occasional use of some heavy plant. It is an open question whether repair shops should not be entrusted to an organization separate from any at present existing in Army Establishments who would organize " groups " of shops on, say, each line of supply. The tonnage of material required is not of such proportions as to render proximity to a store depôt or even to a port essential. Again, facility of transport between armies and shops will be the controlling factor in determining a site.

At any rate, they should be kept quite distinct from " factories."

33. *Storeholding, generally.*—Only the fringe of this subject can here be considered.

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(i) Generally engineer stores may be divided into a few definite store groups, as :—

Timber.
Trench stores.
Huts and hutting stores.
Water supply plant and stores.
Electric light plant and stores.
Workshop plant and stores.
Bridges and bridging stores.

It will be found that it is easier to define a store by its eventual use than by such generalizations as " textiles," " hardware," etc. Such definition will also result in better depôt organization. In France we made " machinery " one store group. This resulted in difficulties which need not be specified; but my own experience is against a repetition of what I now consider to have been an error.

(ii) An area of a depôt must then be assigned to each of these " store groups ; " with a separate store-holding staff and a yard staff. The function of the store-holding staff is to keep the tally records of the stocks of the group, to check receipt and issues, and to know exactly where every store in the group lies, and to see that their area contains no stores belonging to other groups; in general with the *custody* of the stores. The yard staff are assigned the function of stacking in accordance with instructions, generally in accord with the principles laid down under " Depôt Lay-out " and " Depôt Organization ; " with the supervision of labour discharging, sorting, and loading; and with safety precautions against fire and theft: that is to say, generally with yard maintenance.

(iii) These group and yard staffs are controlled respectively by a Chief Storekeeper and a Chief Yard Officer.

(iv) An inspection staff is essential with plenary powers to pry into everybody's business, with a view to checking correctness of the tally-card stocks, and statistical records, investigating returns, discoveries, stores mislaid in wrong group areas. In addition to such general spy work, they are assigned the duty of obtaining by short circuit methods information required as to the exact position at the moment of any of the multitudinous stocks. Higher authority is apt to expect such information to be telephoned within half an hour of receipt of an enquiry.

In a depôt covering 220 acres this cannot be done by constitutional methods following the normal chain of command.

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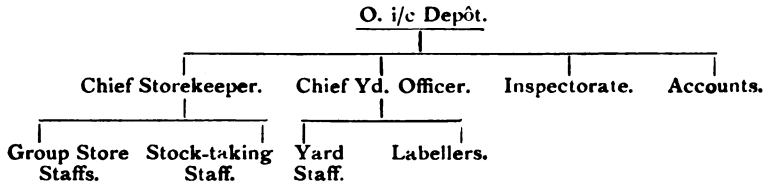
(v) Finally, an Accounts Branch is, of course, essential.

Unfortunately the Army Accounts System in vogue in 1914–1918 with a view to the prevention of fraud was based on a system which did not lend itself to the recording of the statistical information essential to the E.-in-C's control of the distribution of Engineer Stores. As a result a separate statistical set of records was necessary.

34. The general organization of a depôt of engineer or bulk stores will therefore normally be as indicated in the following table :—



35. An Assistant Director will control the O. i/c Depôt, the various factories, and the port staffs in his area.

36. A Port Officer with a small staff is required at each port, charged with the following duties :—

He will in general watch the interests of his service ; report any undue rough-handling of stores ; label trucks for his depôt ; use his best influence to procure, so far as is reasonable, homogeneous loading of trucks *ex* ship ; report to O. i/c Depôt by telephone each evening truck numbers dispatched and approximate contents ; and will see that no stores consigned to his Director are mislaid in dock areas.

This is a task which requires considerable tact and energy.

37. Economy of man-power is a most important consideration. In this respect, officers in a theatre of war are apt to lose their sense of proportion and to indulge too much in opportunism. The temptation to do so is very great, for a supply officer is naturally judged rather by his efficiency than by his economy ; rightly so, indeed, but nevertheless he must obtain efficiency at the minimum cost.

It is, therefore, only just that he should be given such orders concerning economy of man-power as will take some of the responsibility off his shoulders. He can, if the necessity is brought home to him, so organize work and lay-outs as to reduce the number of " handlings " and the distance of carry to a minimum. He can also curtail the number of " employed " men.

Two orders were, therefore, issued to engineer store depôts in France.

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(i) Involved the calculation set forth in the History of the *Supply of Engineer Stores and Equipment*, page 86.

The fundamental idea was that :—

(*a*) On the average no store required to be handled more than three times, once into the depôt, once in the depôt for sorting, once out of the depôt.

(*b*) An efficient lay-out would reduce each handling to an average of 25 yds. carry and 10 ft. lift.

(*c*) That even low-fed prisoners of war could handle under conditions given above 6 tons daily.

Therefore, the allowance of labour could be restricted to one labourer for every two tons received into the depôt in the average day.

(ii) Involved the principle that it is the duty of a C.O. to maintain his men's morale, reduce " casualties " to a minimum, and cut down all " employ " to a minimum ; that 5% was about the maximum which could be on leave at a time. Therefore, for every 100 British Military personnel on the strength of his depôt he must produce 75 " on the works." The remaining 25% must include all leave, sick, and all " employed " men. On the whole it was found feasible to work to these two restrictions.

Distribution.

38. It has already been observed that engineer stores have inevitably to be issued on the basis of " rations ; " for Armies' demands far exceed the possibilities of supply. It is perhaps doubtful whether Armies could have used all the stores for which they asked ; probably demands were framed rather with a view to obtaining, and maintaining, in Army zones a large reserve against any such contingencies as a breakdown of transport or the necessity of constructing an entirely new defence line.

Be that as it may, the demands had to be cut at G.H.Q. to the average of the E.-in-C.'s forecast of six months' requirements.

The ration for the month for each Army having thus been decided by the E.-in-C. on the basis of :—

(*a*) The monthly provision.

(*b*) Special consideration of the operations on the front of the Army concerned.

(*c*) The retention of an adequate E.-in-C. reserve ;

The C.E. of each Army communicated to the affiliated depôt, his sub-division of this ration between Corps.

In the spring of 1918 the situation altered with such rapidity that it was found necessary by E.-in-C. to order weekly instead of monthly rations ; this fact is worthy of note, inasmuch as the long " settled "

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conditions of the western front cannot be regarded as normal; but the general system of distribution was determined by the existing conditions and must not, therefore, be taken too rigidly as a guide to action in future wars.

39. From time to time Corps endeavoured to fix the dates on which trains should arrive, or to fix an order of priority for dispatch. This is frankly unworkable. Depôts must be given a free hand to get up the stores ordered within the period ordered. Bulk stores dispatch cannot be organized on a parcel post system.

40. Moreover, it is necessary that the tonnage to be sent to each named destination should be so divided up as to represent a definite number of train loads. As has several times been observed, it must be accepted as a fundamental axiom that the dispatch of single trucks, or indeed of anything less than a train-load, is prohibited by transport conditions, and, moreover, that one train-load cannot be divided between more than two stations, which must, in addition, be on the same branch line.

41. This condition is somewhat less rigid for distribution in the back zones (L. of C.) but even so the period of transit of isolated trucks is a very uncertain factor.

42. The principal feature to be noted under distribution is that the "ration" is determined by the E.-in-C. and the G.S. based upon information supplied by the supply service as to quantities available in depôt.

RAIL TRANSPORT.

43. Having received from E.-in-C. instructions as to the ration allotted to the various Armies, and the indents of the Director of Works and other branches, the stores branch must now reduce these to tons and train-loads, and then calculate the number of trains required in the month for dispatch of stores.

It will be ascertained from the Q.M.G. staff whether there is a probability of the allocation of the required number of trains. If operations or other considerations render it improbable that a sufficiency of trains can be allocated, it will be necessary to inform the E.-in-C. at once so that he may decide in what respects to reduce his allotment of stores.

44. It did occur that C.E.'s of Armies were on occasions urging the dispatch of stores whilst at the same time the D.Q.M.G. of their Army was allotting all the trains allocated to him for the transport of other stores. The remedy in such event is obviously not in the hands of the supply services.

45. The general principles of rail transportation have been enunciated in foregoing paras. (5, 6 and 7, 10 and 41); the system of dispatch of "pack trains" has been detailed in para. 30 (vi).

46. If the front line be stabilized for any considerable period, it may be possible to relieve rail congestion to some extent by

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establishing a line of supply by an inland waterway. In general, however, inland water transport is most efficient when employed for bulk transport between fixed points, and in France was, therefore, of the greatest value in relieving the strain on railways when clearing stores from ports to depôts.

Similarly, in a river war it will normally be employed working between fixed points on a line of supply, and will not be found to be at its maximum efficiency if employed as column transport following up an advancing force.

47. As regards rail transport, the principle to be noted is that the (inevitably) insufficient transport accommodation is allotted by the Q.M.G. and his staff; in consequence the E.-in-C.'s allotment of engineer stores can only be fulfilled if circumstances, or the instructions of the C.-in-C., permit the Q.M.G. to allot sufficient transport.

Decisions giving priority to any special category of store must obviously rest eventually with the General Staff. For example, it is only the General Staff who can decide that engineer stores shall be forwarded at the expense of ammunition, or personnel trains.

48. The vast quantity of engineer stores and, for that matter, ammunition required for a serious attack on entrenched enemy positions, must in effect be got to the required zone, before troop concentration commences. The difficulty of so doing without "giving away" the intended attack to the enemy gives rise to serious reflections which more appropriately belong to the ensuing section.

Reception and Distribution in Army Zones.

49. There was at times some consensus of authoritative opinion that R.E. Corps dumps became of excessive volume during the long period of stabilization from 1915 to March, 1918, on the Western Front. It is not difficult to schedule the arguments both for and against large Corps dumps; it is necessary to do so before attempting a solution.

50. Pre-War regulations and organization envisaged the establishment of an advanced R.E. Park for every two Corps, the park to be an "accounting" unit.

In effect, the R.E. park either formed the nucleus of a Corps dump in some cases, or in others became a "paper organization" accounting for stores which it never handled. In certain cases it was the actual custodian of stores "blacklisted" by the C.E. Army; that is to say, stores which could only be issued on his authority, and were not at the disposal of C.E. Corps.

In the French Army it was apparently a sort of transit store for two annexed Corps dumps. In effect, in the British Army the Corps dump was the recipient of stores *ex* base and was sited on a railway at a safe distance from front line. From it stores were issued

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both for Corps use and for the Divisional R.E., involving in the latter case heavy road transport. Divisions were, as a rule, somewhat "independent" in their execution of siege works, and were not compelled to work to an area scheme of works, under control of Corps H.Q. directed by Army H.Q. Under these circumstances C.E. Corps appears to have retained control of trench stores with a view to preventing wasteful use on works not entirely approved by the Corps Headquarters.

51. Reference has already been made in para. 48 to the disadvantages of rushing up large quantities of stores, just before an intended operation. C.E.'s had also an uneasy feeling at all times that rail transportation might be unavailable just at the moment when a forward move of either side rendered necessary the construction of a new trench system requiring heavy consumption of engineer stores. This feeling was, of course, more prevalent when the absolutely front-line trench was considered to be the main fighting line, and was less apparent when this trench began to be recognized as the outpost line.

The result was a heavy accumulation of reserves in the Corps dump, which was again reflected in the accumulation by lower formations of their reserves.

52. Whilst this view must meet with some sympathy, it is essential that the disadvantages inherent in the consequent accumulation of reserves should be more fully realized than was the case.

(i) Such accumulation tends to dissipate and immobilize the E.-in-C.'s reserve of stores. It may well occur, and did in fact occur, that stores urgently required on one sector were not available, because they were locked up in another sector.

(ii) It is very wasteful of stores; one unit has accumulated reserves and is relieved by another unit which regards, and treats, such reserve, as an excellent means of enabling it to execute sundry unauthorized works.

(iii) A Corps dump is not an accounting unit, and although statistics of its stocks were kept, no reliable statistics could be obtained of the stores locked up in minor dumps of lower formations. In any case, not only are the stores immobilized owing to the practical impossibility of moving them back by rail, but they are quite beyond E.-in-C.'s control and are lost to him as a reserve.

(iv) Should the Army make a considerable advance, it must either:—

Abandon its stores dumps; or

Drag them forward, thus encumbering itself with heavy transport; or

Leave men behind to guard the dumps, thus extending its tail at the expense of its fighting head.

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(v) If the general organization involves all engineer stores passing through the Corps dump, this spells heavy road transport to the front line, for obviously such large dumps must be kept behind zones liable to heavy shell-fire.

53. The system now to be enunciated is put forward as a suggested solution; it met with the approval of one or two Army C.E.'s, at any rate in principle.

To some extent it presupposes and is contingent upon another suggested general principle, which is that an Army zone should be fixed at a certain depth dependent upon long-range shell-fire. Let us suppose it to be 20 miles deep from the outpost line. This zone would move with the outpost line. Up to the 20-mile limit all administrative operations, such as engineer works of all descriptions, transportation and supply would be conducted by the services of the rear zones (bases and L. of C.), with all the accountancy and other control prescribed for rear zone services. Forward of the 20-mile line, administrative operations would be conducted under orders issued by the Army Command concerned, according to the conditions and circumstances of the moment. For example, as regards rail transport, the line would be treated as a frontier; trains passing across it forwards would be freed from all traffic regulations of the rear zone and would be operated by an Army railhead staff.

54. As regards engineer stores, an advanced depôt would be created just behind the Army zone, into which could be poured such stores as the C.E. Army, subject to the approval of the E.-in-C., might desire to see within his reach as an emergency reserve, which could in emergency be obtained by Army road transport.

The stores would, however, remain on charge of, and be accounted by, the stores branch; and would remain an E.-in-C. reserve.

It is suggested that, with such a reserve within reach, independent of rail transport, issues of stores for current works in progress might be made direct from base to the point on rail nearest to the work, that is to say, to the nearest point on rail which can be operated.

Under such conditions C.E. Army and C.E. Corps would retain control of store expenditure, without actually having to hold and handle stores intended by them for works to be executed by Divisional R.E.

When the Army moves forward it will feel no responsibility then for accumulation in its zone; the advance depôt will be transferred back to base upon the close of the period of stabilization.

Or, if the forward move is only temporary and followed by another period of stabilization, the depôt might be moved forward. In the event of retreat, the loss of stores would at any rate be no greater than under the circumstances which prevailed on the Western Front, and might well be far less.

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SUPPLY OF STORES IN MOBILE WAR.

55. It must frankly be admitted that the war on the Western Front afforded little experience which can be used as a guide for the future.

During the final advance in September and October, 1918, the records of the Directorate of Engineer Stores show that considerable quantities of trench stores were still dispatched at the request of Armies. Perhaps we all had a feeling that another period of stabilization might ensue at any moment. For the most part these stores were subsequently found in various dumps staged in the trail of the advance. Conservatism causes the continuance of established habits after such habits have become anachronisms. It can hardly be assumed that an army on the move will normally require train-loads of trench stores. It will require bridges and bridging stores in considerable quantities, and often water pumps, hose and canvas tanks.

56. A bridge may well require the dispatch of a special train to one point, which presents no difficulty. But as regards all other engineer stores, the demands which may be expected require the dispatch of a few trucks at uncertain intervals to various points. It is further obviously very desirable that such trucks should arrive at the front within 24 or 48 hours of dispatch; for an Army on the move will not demand stores before they are actually required.

Unfortunately it is just this class of transportation which appears to be absolutely hopeless; to collect various consignments into a mixed train at all is apt to congest railway sorting stations; and, if an attempt to do so is actually made, the results are usually most unsatisfactory from the aspect of rapid transit.

Try, even now, with slack traffic on the railways, to consign a "parcel" of goods from the Midlands to the South of England by rail and note the number of days or weeks which elapse between dispatch and receipt. In war the difficulties of the railways can but magnify the delays.

57. There is then a difficulty which must be faced, and the solution found.

It was with these difficulties in view that a recommendation was made in para. 10 that all bulk stores should be collected in and dispatched from one depôt. There would then be a reasonable prospect of making up complete trains with stores for various consignees, such as blankets, tents, sandbags, and engineer stores. It was actually found in 1917 that this method had to be adopted to get forward the bulk stores supplied by R.A.O.D. to R.E. parks and Corps dumps. Ordnance depôts were then included in R.E. base depôts. Later we actually took over these stores.

The inclusion further of railway construction materials amongst

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bulk stores would render it certain that complete train-loads could be made up. It is absolutely certain that railway materials will be required in the vicinity of any bridge to be constructed.

Design of Field Structures.

58. One subject upon which opinion was fairly unanimous was the necessity of designing any structures, whether bridges, huts, steel shelters or pill-boxes, etc., intended for front-line use, so as to be as nearly fool-proof as possible. They will meet with very rough handling, transport over the barest apologies for roads, may have to be carried down C.T.'s, will be erected often in the dark, and then by semi-skilled men. It is therefore not merely "very desirable," but almost essential, that they shall be designed to have a minimum of "parts." Steel shelters, for example, should consist merely of 8-gauge or 12-gauge curved corrugated iron sheets with one type of bolt. All the extras which make the shelter look pretty, and incidentally more expensive, when erected as a sample in a manufacturer's yard, are encumbrances and nuisances to the field engineer.

The new type of steel bridge now under trial appears to be exactly what was, and is, required, provided that no fancy trimmings are added at some future date.

59. For all such stores the ideal is a sausage; the field engineer should be able to demand so many feet run of large shelter, small shelter, "M" type hutting, or even of bridge.

With every 100-ft. run supplied of any such article would go automatically a fixed weight of the (one) type of fastener peculiar to it (nails, hooks or bolts).

60. This principle might even be adopted for hutting. The vision before me is of a demand for 1,000 ft. of Nissen hutting.

This would be met by supply of (say):—

1,500 curved corrugated iron sheets.
5,000 ft. run of purlin scantlings.
250 T-iron ribs.
50 doors.
200 windows.
50 stoves,
and so many cwt. of hook fasteners.
Or in lieu of the doors and windows:—
50 "A" type } gable ends might be supplied.
50 "B" type }

This roofing would be erected on walls made of filled sandbags, or over a pit, thus giving more headroom, whilst providing splinter-proof protection against air-bombs.

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The floors would be provided either by materials found locally or drawn from timber stocks or by supply, where necessary, of marquee floors.

It may be worthy of note that timber floors amount to half the cost and half the bulk of most types of hut and really impose the limit of supply.

The principles advocated are :—

(i) Provision of roof covering (of the simplest design) from bases.
(ii) Such provision to be on a basis of feet run.
(iii) Provision of either gable ends, or preferably only joinery to be built into sandbag walls from bases ; to obviate the field troops requiring skilled artisan labour.
(iv) Construction of walls and floors *in situ*.

This suggestion clearly means the sacrifice of quality to quantity. Climatic conditions and transport facilities will, no doubt, decide on the extent to which such a course is desirable.

ARMY ORGANIZATION.

61. During and since 1918 many R.E. officers have appeared to attach great importance to the subject of the relation of the stores branch to the Higher Command.

At the moment the F.S.R. state that " the C.-in-C. will exercise his functions through three principal staff officers." There are no doubt many excellent reasons to be adduced for the alteration of the word " three " to read " one," " two," or " four." Until such alteration has been decided and functions allotted to the *x* Principal Staff Officers it would appear somewhat futile to attempt to fit the stores branch into any hypothetical new organization of the Field Command.

So far as " co-ordination " is concerned, this word can perhaps be given undue weight ; the co-ordination wanted is that which will ensure the maximum supply of the right stores at the right moment at the right place.

Clearly, so far as field engineers are concerned, the E.-in-C. ; and so far as rear zone engineers are concerned, the Director of Works, whatever be the organization of the Higher Command, can alone decide upon the class and quantity of stores required and the locality in which they are required. Those problems have their own inherent difficulties, but when these are overcome it must not be forgotten that the real crux of the problem lies on the ability to transport the stores from factory to site, a problem for solution by Q.M.G. branches at home and in the theatre of war. Far too many, not only of R.E. officers, but of civil business men, fail to grasp that bulk stores cannot be got to the site of the work by mere indent for transport on a R.T.O. or the methods of a parcel freight agency.

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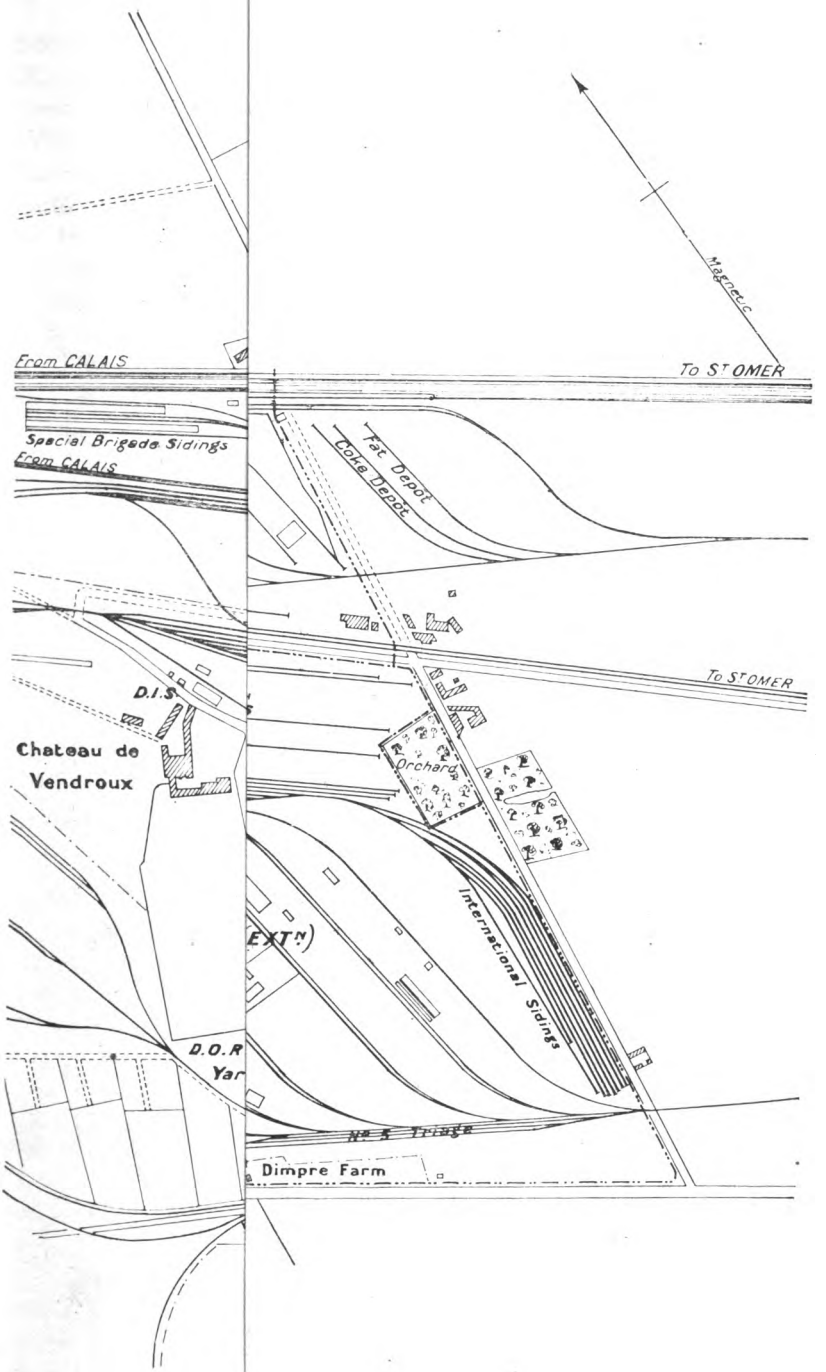

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Stores of the best type and in ample quantities are useless to the R.E. unless they can be got to him; to do so involves the most intimate, constant, and rapid co-operation with all transport services.

Whatever be the higher organization adopted, it must provide for such co-operation as the prime essential. Depôts and depôt organization must similarly be designed in the first place with a view to facility of transport operation.

62. At the same time, the organization must be one which is in sympathy with and "speaking the same language" as the R.E. whom it serves. To this end many, if not most, of its higher staff should be R.E. officers fresh from the command of R.E. units. The ideal staff for a depôt would probably be a triumvirate of a R.E. officer, a "Q" staff officer, and a transportation officer.

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PRESERVATION OF COAST LINE.

By LIEUT. G. G. McD. CARR-HARRIS, R.E.

ALONG most shores are to be found large quantities of rip-rap. Although this primary feature is often buried in sand and shingle, yet it was, no doubt, formed by the action of the waves and tidal currents gradually washing away the finer portions of the shore and leaving the rougher. In time the sand and shingle accumulate, if the conditions are favourable, thus forming a secondary feature. It is through the developing of one or both of these two features that a natural protection against the sea is created.

It should be remarked that either natural rip-rap or a shingle beach seem to be the only imperishable protection for an exposed coast line. The success of such an agent is largely due to the perfect foundation which it has, and itself filling in all tendencies to scour. The utility of rip-rap has been generally recognized, but the formation of shingles or bars to a somewhat lesser extent.

The methods by which a beach can be formed may well be examined, and artificial methods for obtaining sand and shingle deposits become of importance. It is, therefore, towards this section of the subject that we shall give our attention.

There are at least two artificial methods for obtaining shingle beaches which have been tried, and which have proved successful :—

(1) The construction of groynes.
(2) The sinking of mattresses or rafts of brushwood.

(1) Groynes are used extensively in England, particularly on the South Coast. These sea fences are built out at an angle to the shore line and collect the drifting shingle. They are usually constructed of planking supported on piles. When the drifting shingle is arrested in them it is heaped up on one side, leaving the leeward side quite bare. For this reason the groyne, if of any height, should be of strong construction. If, however, a low groyne is built, it will not require the same permanence and strength as it will, in all probability, be very soon buried in the shingle. Low temporary groynes of, say, 2 ft. in height, would seem to be best, as they may be raised afterwards another 2 ft. or so.

Mr. E. W. Wheeler's book, *The Sea Coast*, gives a very good description of the system of groyning. In it he says, " After a beach

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has been raised to nearly high-water mark, or a little above mean-tide level, the accumulation of shingle will proceed without artificial aid, when there is a continuous supply of drift." It would, therefore, appear uneconomical to construct groynes after high-water mark is reached.

No definite rule can be laid down as to the length and distance apart of the groynes, but as a rule the length can be assumed to be that distance between high-water mark and low-water mark of spring tide; the distance apart being the same as the length, but not usually under 100 yds.

Finally, the movement of drifting material is governed by the carrying power of the water and that carrying power is governed by the speed with which the water moves. This, of course, varies with wind and tidal currents in each locality. Hence, it may be wise, before siting your system of groynes, to make certain by experiment the actual length, type, and position you require for that locality.

(2) The sinking of mattresses or rafts of brushwood. Some time back the U.S. Government undertook extensive reclamation and coast-line protection work along the coast of Florida. The work was carried out by the U.S. Army Engineers on rather a gigantic scale. One of the engineers in charge is reported to have said that, as an ocean barrier, every other method failed except the formation of artificial shingles and bars. The expedient that was used for obtaining these differed somewhat from the groyne.

Saplings and brushwood were roughly interwoven in rafts, say, 200 ft. long, 10 ft. wide, and 3 ft. deep, and the whole secured by chains or strong wire. These rafts, or mattresses, were towed out to position, piles driven through them to fix them, and sunk. This allowed the work of construction to be concentrated in one place where the necessary facilities existed.

In using this expedient for collecting shingle, the direction in which the mattresses lie must be settled. As this location will vary somewhat with the different tides and currents, experiment, again, is the surest way to settle it. In general they would be transverse to the prevailing winds and currents. In this connection it might be well to experiment with several different mattresses over a period of, say, twelve months, before finally carrying out the scheme of defence. In the case of reversing currents, as on tidal seas, the mattresses might be sited to utilize both currents, one system of mattresses for currents right to left, another system for currents left to right.

It may happen that the formation of shingles or bars cannot be effected by either of the two means described, and to show that nevertheless the possibility of doing so still exists, the following instance is given.

The main line of S.E. & C. Railway running between Dover and

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Folkestone, follows the sea-front. It is an interesting bit of coast-line; and perhaps the best known landmark is The Warren. However, that particular bit from The Warren to Abbots Cliff, in the direction of Dover, concerns us. Here the sea had seriously threatened the railway at one of its most vulnerable points, *viz.*, where the line entered a tunnel. Every effort had been made to maintain the original coast-line. Groynes had been built, but failed to collect either sand, or shingle. An expert who was called, considered it was impossible to save the line, and as a possible solution recommended the building of a strong sea wall at once. This was done at considerable expense, the wall being little under a mile long, but after a time it was found that scour was occurring at different points under the wall, and it would soon be useless.

However, a suggestion was made to bring a few truck-loads of shingle and dump it where scour had occurred. This was acted upon. The shingle showed signs of remaining, and more of it was dumped. Scour was checked and the wall preserved intact. What is, however, of more interest to us, 102,000 cubic yards of shingle have since been transported and dumped here, forming a broad and expansive beach. This appears to be permanent, and no anxiety is now felt in regard to the safety of the line at this point.

It is curious that groynes built previously failed to collect the drifting shingle, but once the artificial beach had been formed, the shingle, not only remained in the groynes, but accumulated there.

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CORRESPONDENCE.

THE LATE MAJOR-GENERAL SIR REGINALD S. CURTIS, K.C.M.G., C.B., D.S.O.

To the Editor, R.E. JOURNAL.

SIR,

May I be allowed to add to the memoir of Major-General Sir Reginald Curtis, which appeared in the June number, a few words of appreciation from one who was very closely associated with him in the later years of his career? He came to Aldershot as O.C. Troops and Companies in the early part of 1910. At that time I was Chief Engineer of the Command, and under a Commander-in-Chief who very thoroughly realized the importance and relative value of R.E. in field operations. Many were the schemes which Curtis and I worked out together, and many were the interesting staff tours and manœuvres in which we had the chance of practising our proposed developments of R.E. work. For Curtis was, by nature and training, one who took wide views. He realized the great value of parade efficiency, but he knew it was only a step to greater usefulness, and must take its due place in the co-operation between R.E. units, with their varied characteristics, and other arms of the Service. There were many opportunities of developing all this, in the annual courses of instruction, in brigade and divisional training, and at manœuvres, and our association in all this is a most charming memory. There were also some great State functions—the funeral of King Edward, the Coronation and visits to Aldershot of His present Majesty—and there are some sad memories, such as the fatal accident to Capt. Beresford, a few minutes after Curtis and I had inspected his troop on a lovely summer morning. Throughout it all there were episodes of a very kind and benevolent character, he was always doing some kind action to some "lame dog," and never saying anything about it. We were associated together in starting the R.E. Old Comrades' Association.

Later on we were both sent to the War Office, sorely against our desires. There we were in different departments, but for all that, in the closest co-operation. During the strenuous years 1914–1916 I do not think there were many days in which we were not in one another's rooms. We knew that the work and the personnel of the Corps had to be in absolute harmony in the great struggle. More than this, we knew that the policy which was followed, often in the teeth of much opposition, might be of very far-reaching influence, so it was not merely a matter of temporarily gaining one's point, but of the future of the Corps in peace and war. Often I sent to him for his criticism the draft of some of my minutes and often I had from him the soundest and most prudent counsel. A more charming and capable colleague one could not have.

But the poisonous atmosphere of Whitehall was too much for him.

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He had to work in a dark, stuffy office day after day, while others were able (as I was) to spend a good deal of time on inspections. I do not know whether it laid the seeds of the painful disease of which he died, but I do not think he was ever quite the same again.

During this last year he wrote to me often—brave, cheery letters, full of fun, but with full recognition that he would never recover.

"English in heart and in limb,
Strong with the strength of the race to command, to obey, to endure."

Yours faithfully,

GEORGE K. SCOTT-MONCRIEFF, *Major-General.*

REVIEWS.

ENGINEER TRAINING, 1922.

THIS little book is excellent, and the officer responsible for compiling it deserves congratulations, not only for the soundness of the principles inculcated, but for the clear and terse expression of them. Past experience has shown the gradual development of engineer training, from the days prior to the South African War when it was carried out on a rigid principle, entirely apart from other troops, and with little higher supervision (from C.R.E.'s or Generals Commanding), to the early years of the present century, when co-operation and tactical combination of all arms began to be established and Divisional C.R.E.'S were appointed. Now, at last, the lessons of the Great War have shown that "throughout their training all ranks of *engineers* must be taught to realize the close relationship between their own rôle and that of the other arms in battle" (pp. 2 and 3). This is a great step gained, and a further advance is to be found in the new departure that "higher commanders will arrange for the temporary attachment of engineer officers and N.C.O.'s to branches of the service other than their own. Similarly, officers and N.C.O.'s of other branches will be temporarily attached to engineer units. Higher commanders will create opportunities for training the various arms together by means of combined exercises and operations" (p. 3).

This is a sound and admirable foundation, and in reading it one cannot but regret that it was not realized long ago.

The application of sound principles to the details of training is equally good. It is pointed out (p. 4) that, while an officer cannot possess the manual dexterity at a trade which any of his men may have, he has knowledge of the application of that trade, and that knowledge enables him to use the dexterity of the other to the general advantage. He must be as zealous of his men's trade proficiency as he is of their smartness and skill at arms (pp. 34, 35), for the efficiency of his unit or section is dependent on both military and civil qualifications, and the combined value of these may be incalculable in many operations of war.

The broad principles of command and training, the delegation of authority, the power to impart knowledge, the influence of personality, which are common to all branches of the service are reiterated with special reference to the organization of engineers—an organization which

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owing to the size of the units and the trade occupations of the men, lends itself well to the exercise of discipline, mutual working between all ranks and delegated command.

Chapter II. gives a short summary of the training of R.E. officers. This is a valuable departure from previous publications, for it defines the aims and scope of the S.M.E. training to an extent which is not only valuable to engineer officers themselves, but is useful to other arms also, leading them to know—what otherwise they could not possibly know—how much to expect from any R.E. officer. The programme is a very extensive one, but at all events it is definite and precise. That in itself is of value, for at one time, not very long ago, it was largely left to the instructors at the S.M.E. what subjects they should follow in their special branch. Another useful innovation is the announcement that certain officers should be attached to representative engineering firms in Britain or the Dominions.

Recruit training, which forms the subject of Chapter III., deals with the military training common to all arms and also to the special training for sappers, recognizing that the diversity of employment of different engineer units must admit of certain elasticity in progressive instruction. The annual training dealt with in Chapter IV. defines, among other matters, the relations of the chief engineer of a command, and the C.R.E.'s of divisions, and of districts, to the engineer units in the matter of annual training. This, too, supplies a want, for, prior to 1914, there was ambiguity on this subject. The relative position of units and the works staff in connection with the employment of men at their trades is also given. Some of the paragraphs dealing with training in conjunction with other arms are specially sound. The work of engineers in war, being either constructive or destructive, cannot readily be imitated in peace, and " from its very nature it involves a considerable expenditure of time and money, both of which factors militate against the production of war conditions on manuœvres with sufficient reality. Care must be taken therefore to guard against the formation of erroneous impressions as to the part played by the engineers in battle." This is very sound wisdom, and it is earnestly hoped that all arms will take it to heart.

The collective training of field squadrons and various classes of companies is next dealt with, obviously based on recent war experience. The characteristics of each unit are recognized in their special training. Emphasis, in field units, is laid on engineer reconnaissance, and on *liaison* with other arms, both vitally important matters. In connection with railway companies it is noticeable that the training will be directly under the War Office. The programme for these units is large, and it seems doubtful whether facilities for a large proportion of it are available ordinarily.

Chapter V., dealing with drill, calls for no special criticism, except to say that the excellent principle is laid down that the first-line transport of engineers, being an integral part of the unit, must not be separated from it. This has, of course, been known to R.E. officers for at least 35 years, but other branches of the Army have not always realized the fact. The drills based on this are very simple.

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Part II. (Chapters VI. to X.) deals with war, and, while some of the chapters await the publication of F.S. Regulations dealing with specific subjects, others deal with practical matters resulting from war experience of a valuable nature. There are several most important principles enunciated. One of these lays down that, while engineer work must be carried out according to the conditions of the tactical situation and with the plans of the commander, yet, as time is an important factor, the engineers must receive early intimation of a commander's requirements. This is one of the most urgent necessities of successful R.E. work and emphasizes the necessity for close touch between the General Staff and the R.E.

It is hardly possible, in the necessarily limited space of a short review, to do justice to the admirable summary—some fifty pages—of the duties of engineers given in this section of the book. It deals with the nature and control of work, technical approval of designs, responsibility for and methods of execution of work, inspection of work and units, precautions, duties on the march, water supply, passage of rivers, bridging, road-construction, attack, defence, retreat, position warfare, co-operation with other arms, duties of Corps engineers and of Army engineers. Possibly some of the subjects are treated in rather too detailed a manner, and therefore encroach a little on the functions of a manual of field-work instruction. On the other hand, this is a good fault, if indeed it be a fault at all, for it is better to have an important point repeated than to allow it to be omitted on the understanding that it will come up in some other publication.

The book generally is very compact and easily read. It will be invaluable not only to R.E. officers, but to higher commanders, to the General Staff, and to those who are responsible at Headquarters for supplying R.E. needs.

G. K. S.-M.

LA RUÉE VERS CALAIS (15 Octobre–13 Décembre, 1914).

Par le GÉNÉRAL PALAT (Librairie Chapelot, prix 12 *fr.*).

THIS book of nearly 400 pages forms the eighth volume of General Palat's work, *La Grande Guerre sur le Front Occidental*, but is complete in itself, giving the story of Battle of the Yser and the First Battle of Ypres. The progress of the fighting each day in the various sections is described in detail, working from north to south, the account of the action of the British Army being taken from Lord French's dispatches and from his book, "1914." Needless to say, the action of the French troops is given in greater detail than that of their Allies, and it is well that the magnitude of their effort during this momentous period of the War should be fully recognized, and that the debt of gratitude owed to Foch, Grossetti, D'Urbal and Dubois should be acknowledged. Their incorrigible love of the attack, even in the most desperate conditions, is very striking, "le parti le plus audacieux est souvent le plus prudent," but did not increase the popularity of some of the junior staff officers, who had to carry their orders among the fighting troops, as in the case

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of the officer who was nick-named "en honneur de son nez, 'le Tapir de Flandres.'" "A entendre ces jeunes sots, tout devait tombre devant nous et l'ennemi n'existait pas," was the remark of one exasperated general. The narrative is illustrated by five small sections of the 1/40,000 map, which is probably the most suitable method that could have been devised to meet conditions which changed daily, and often many times a day, but a key plan would have been helpful to the reader who is not already well acquainted with the ground.

F.E.G.S.

NOTICES OF MAGAZINES.

MILITÄR WOCHENBLATT.

No. 39.—In an article by General von Zwehl the percentage loss in officers in the various branches of the German Army during the War is given as 75·3 per cent. for Infantry, 7·4 per cent. for Cavalry, 8·5 per cent. for Field Artillery, 3 per cent. for Garrison Artillery, 3·3 per cent. for Engineers and 2·5 per cent. for the remaining branches.

General von Kuhl defends Ludendorff against Dr. Delbrück's attack in his recent book entitled *Ludendorff's Selbstporträt*, according to which Tirpitz and Ludendorff are responsible for the destruction of the German Empire.

A paragraph is devoted to the equipment carried by the infantry soldier. It quotes 25-30 kg. as being the standard weight usual in Europe before the war. It describes how the conditions of the late war made for a material increase, but points out that science has proved that this increase cannot be made without destroying the efficiency of the infantry soldier. This, under modern fighting requirements, is declared to be truer now than ever before. A satisfactory solution to the problem has yet to be found.

No. 40.—Lieut.-General von Altrock, in *Geschichtliche Betrachtung zum Bismarcktage*, pleads for a united front among all political factions in all that concerns German Foreign Policy.

No. 41.—Little of special interest.

No. 42.—The new *Berufspflichten des deutschen Soldaten* $L2\frac{4}{2\frac{1}{2}}$ supersedes the former *Kriegsartikel für das Heer und für die Marine*. It consists of fifteen articles which have to be read out to each recruit and repeated annually.

It lays stress on the virtue of honour, obedience, duty, courage, patriotism, fidelity, comradeship and clean living, and points out that the private soldier can attain even to the highest positions.

No. 43.—A favourable review of Volumes I. and VIII. of General

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von Freytag-Loringhoven's book on the Great War 1914–1918 appears. These are the first two volumes published. They are sub-divided into sections written by various military experts, the whole being edited by Freytag-Loringhoven.

The first volume contains seven sections dealing with the war from the beginning till the Spring of 1915. The first section deals with the political reasons for decisions taken at the beginning of the campaign; the second with armaments on land; the third gives a summary of operations; the fourth deals with the campaign on the Western Front till the middle of September, 1914; the fifth with the rescue of E. Prussia; the sixth continues with the war on the Western Front till the middle of April, 1915, and the last describes the war on the Eastern Front during the Autumn and the Winter, 1914–1915.

The first section in Volume VIII. deals with the expansion of and the recruiting for the Army during the war; other sections with the provision of horses, arms and munitions. Later sections describe the work of the Engineers, Signal Service, Army Service Corps, etc.

The *Militär Wochenblatt* quotes the following progress report on the work of the disarmament commission from the latest information supplied by the *Reichstreuhand Gesellschaft* :—

	Number.	*Destroyed.*	*Remaining undestroyed in Store.*	*to the Govt. or to the Allied Powers.*
Rifles and Carbines ...	5,879,256	5,855,979	8,588	14,699
Machine-guns	104,477	104,084	14	379
Mine-throwers and Barrels	28,440	28,440	——	——
Guns and Barrels	54,415	54,415	——	——
Gun-carriages	27,869	27,869	——	——
Loaded Shells and Bombs ...	38,770,000	35,400,000	3,300,000	70,000
Rifle and Hand-grenades ...	16,500,000	14,400,000	2,100,000	——
Detonators	60,100,000	59,300,000	800,000	——
Rifle Ammunition	468,000,000	425,000,000	35,000,000	8,000,000
Aeroplanes	14,014	13,381	4	629
Motors for Aeroplanes ...	27,711	24,045	15	3,651 (delivered up without destruction)

No. 44.—Major Saring tells us that the reorganization of the Russian Red Army can be regarded as complete. It consists of approximately 1,500,000 men. Various courses of instruction up to three years' duration have been started for leaders.

Trotzky is the Chief of the Army, with Skylzansky as his deputy. Particulars concerning the higher command with names of those holding office are given.

H. de C. TOOGOOD, *Capt., R.E.*

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REVUE MILITAIRE GÉNÉRALE.

February, 1922.

The Czecho-Slovak Mobilization.—The arrival of Karl of Hapsburg at Odenberg on 21st October, 1921, to assume the Hungarian crown raised a difficult situation for the states of the Little Entente; at first the Hungarian government seemed little inclined to oppose him. Czecho-Slovakia was the first to realize the danger of this violation of the peace treaty, and determining to act energetically for the general good ordered the mobilization of the five classes 1895–99. The Army, constituted after the Declaration of Independence from Czecho-Slovak formations which had fought with the Allies, and of national units incorporated during the war, was increased later by units repatriated from Siberia, but the formations lacked homogeneity, and material was incomplete. In March, 1920, every citizen of Czecho-Slovakia without distinction of nationality had been made subject to compulsory military service. Owing to the numerous nationalities represented in the Republic, Czechs and Slovaks, Germans, Magyars, etc., it had been ordained, in spite of the technical difficulties, in order to ensure consistency, that recruiting was to be national and not regional, and that not more than 30 to 50 per cent. of other nationalities were to be incorporated in each Czecho-Slovak unit. The work of organizing the Army on a war footing had been in hand during the three years 1919–21 under the direction of a French Military Mission; 12 Divisions, each of two brigades of two infantry regiments, had been completely constituted, with divisional artillery consisting of two groups of field batteries, a mountain battery and a heavy battery, two companies of engineers, a squadron of cavalry, and necessary services. Besides these there were two mixed mountain brigades, each consisting of two infantry regiments, a regiment of two groups of mountain artillery, a company of engineers, a squadron of cavalry and services; also three brigades of cavalry of three or four regiments, and an artillery reserve of a certain number of regiments of field and heavy artillery. This organization was far enough advanced to allow of the Army responding to the effort demanded from it on mobilization. The various operations—calling up the reservists, completion of formations and commands to a war footing, dispatch of reinforcements to formations already in the field, and creation of new formations—were completed in good order and in the time prescribed. Seventy-six per cent. of the 300,000 men affected by the order presented themselves within the regulation period, which for various reasons may be considered very satisfactory, and constituted a direct denial to the propaganda of Magyar irridentism. Both Slovaks and Ruthenes responded to the call, thus testifying their attachment to the new state and their intention to withdraw from Magyar influences. Germans of Bohemia and Magyars of Slovakia were equally ready. The material mobilization was equally satisfactory, only 45,000 men were incompletely clothed at the depôts, and this could have been remedied in less than a month. Czecho-Slovakia possesses more than half the industries and nearly all the war industries of the old Austro-Hungarian Empire, and

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the War Ministry had ascertained that the mobilized industries, besides satisfying the demands of the Army, could lend effective aid to the states of the Little Entente, and their faith was justified. By the light of the industrial mobilization Prague appears as the industrial centre of the Little Entente in case of war, and representatives of the latter have discovered this for themselves.

The capture of Karl and submission of Hungary did not permit of testing the Czecho-Slovak army in the field, but the discipline and smartness of all units are proof of their real military value. No untoward incident marred the mobilization; transport, even from Moravia and Bohemia to the Hungarian frontier, worked without a hitch and without interfering with the normal traffic of the railways, and the deployment of the covering troops took place according to plan. It was in conjunction with the Little Entente that Czecho-Slovakia undertook the conduct of the war against the Hapsburg dynasty, and during the whole crisis the various general staffs were in close touch, and the states of the former have learnt the valuable services which the army and industries of the latter can render. A confidence has been produced which will bear fruit in the future. At home the experience of the civil and military authorities in working together for a patriotic end has created an atmosphere of mutual trust from which the army will be the first to profit. The insight gained by the G.S. will enable them to perfect their machinery for mobilization.

With Regard to the Offensive of March, 1918.—By Major Toussan.—The writer considers that when Ludendorf decided on his huge offensive of March, 1918, he can hardly have expected it to be a success. With so many factors in his favour he was yet short of draught horses, cavalry and tanks, and, realizing as he did the depth of the thrust he must make to secure a strategic success, it is hardly likely that he can have hoped to gain full advantage from the effort. At any rate, after seven days of fighting, on the evening of 27th, he realized that the German infantry had shot its bolt and could advance no further, while his objective, Amiens, had not been taken. Discussing this with his staff he regretted that he had no cavalry to exploit the success, and sketched for them the part cavalry could take in holding open the breach in the line between the British and French to allow his infantry to deploy beyond it. Even if the cavalry had been there, their training and equipment had been so neglected that they would have been incapable of effecting what would be required of them, and he thereby acknowledged that it would have been worth while to have retained properly trained cavalry. An interesting article.

March, 1922.

The Revision of the Regulations.—A continuation of the article by "Lucius," 5th period continued. (1) Those operations which appear most successful at first may lead to ulterior difficulties, and before engaging in them it is necessary to have considered the means by which continual superiority may be maintained. (2) A success may more often be exploited than is generally supposed, and such an occasion should always be thought of as possible, even in operations with limited

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objectives. (3) The enemy artillery need not be destroyed, it can be neutralized, and by this means the length of the artillery preparation reduced, and surprise obtained. (4) The use of masses of tanks allows of surprises being realized. Finally, the success of offensives with limited objectives depends on the mass of material means employed, which cannot be utilized in like proportion in wider operations. Their advantages are the achievement of easy successes, the elimination of risks, and a sensible decrease in casualties.

IV. The Instruction of 31. 10. 17 *on the Offensive Action of the Larger Units in Battle. The Triumph of Method. A New Conception of Continuity.*—The compilers of the new Instructions did not embody all the deductions made from the operations of the second half of 1917, but the conception of offensive operations was profoundly modified. The defensive system was considered to be too deep to admit of being breached by a single thrust widely enough to bring about dislocation of the whole, and as a result offensive action was to be characterized by successive attacks on strictly limited objectives (normal, intermediate and eventual) determined by the possibilities of artillery action. Conducted methodically on as wide a front as possible the offensive would aim at piercing the enemy's successive positions by successive attacks on limited objectives, the system advocated in the Instruction of January, 1916, but the conduct of the attacks very different. In a word, if the first attacks should be simultaneous, along the whole front selected, to effect surprise, the later ones would be separated by intervals of space to be attacked alternately but in such a way that the enemy is everywhere threatened. The preparation of the attack on each interjacent space is governed by the change of position of the artillery, the preparation of communications, the collection of materials and food, alterations in the infantry dispositions and by the artillery preparation or assembly of tanks, and each attack would aim only at the occupation of a single enemy position. Strategic surprise must be sought for by manœuvre, *i.e.*, by opening attacks on several points of the front in order to puzzle the enemy as to where to employ his reserves; tactical surprise by deceiving him as to the exact time and place of the attack, and submerging him by the rapidity of the advance. If tanks are available the artillery preparation might be entirely omitted, if not, the latter must be shortened by neutralizing the enemy's artillery, his concentrations and observation posts, with gas-shell, at the moment fixed for the attack. Still, even now the artillery preparation is estimated to last for three or four days, and neutralization during the artillery preparation, which proved so useful at Malmaison, is not advocated. Preparations of every sort must be carefully camouflaged, and to ensure secrecy the diffusion of orders must be strictly limited.

The *exploitation*, now termed the *development* of the success, though proved possible by the events of 1917, is so hedged about with restrictions as entirely to change the character given to it in the Instruction of 16. 12. 16. In a first phase "development of progress through the fortified position," it is laid down that the advance, gradual and methodical, is not to extend beyond the eventual objective

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except by order of the Army Commander. Its object is to widen the breach, and as this is widened cavalry can be employed to preserve contact with the enemy. The artillery will not be able to ensure barrages, the protection for the advance will consist in the enemy's disorganization and the capture of his batteries. In a second phase, " development of the advance into open ground " progress, still regulated by the higher command, will be characterized by greater rapidity, and it is in this phase that the larger cavalry formations will be employed in advance of the other troops. Still the result will be delay, and the almost total extinction of initiative in subordinates, whose activities are limited to reporting to the higher authorities chances of success, and of preparing to take advantage of them should an order to do so be received, but if favourable opportunities are to be seized the command should be decentralized. Method is also insisted upon in the preparations for the attack by the elaboration of innumerable plans, revised and corrected in each higher formation, involving great inconvenience and serious loss of time.

The Instruction of 31st October lays down as a principle that the larger formations will be formed by temporary groupings having sufficient offensive capacity in depth to carry an attack through to its conclusion (2,000 to 3,500 metres). The Army Corps will normally comprise two to four infantry Divisions. The Division becomes the unit of attack, the useful width of an assaulting battalion being 300 to 400 metres, and its depth of advance 800 to 1,200 metres ; the Division of three regiments will occupy about 1,200 metres of front and penetrate 2,000 to 3,000 metres. The employment of each arm in the different phases of the battle is carefully regulated, that of air-craft in particular, and stress is laid on the importance of mastery in the air. The employment of tanks is also precisely set out. Attention is drawn to the necessity for good *liaison* and communications, and the conditions for success, omitting surprise, which has already been dealt with, are stated to be superiority in equipment of all kinds, complete preparation by conditioning command and troops, by the preparation of plans, by the execution of works of offence and by collaboration between all arms. In short, the Instruction evinces the triumph of method over rapidity; offensive procedure becomes more rigid than ever, and except for its insistence on surprise is a retrograde step in the domain of tactics. It codified the results of long experience of a war of position, but did not educate for the exigencies of open warfare although the disintegration of the enemy's position was provided for, and this, if realized, must lead to fighting in the open until a new organized position is met. The Instruction erected into a system what should have been considered only as a temporary expedient. The infantry were now persuaded that they could do nothing without the support of a powerful artillery, but it should have sufficed, as true at the time, to bring this to the notice of the higher commanders, and not to have sown the idea broadcast through the Army, of which the resources of the infantry arm had lately been largely augmented.

V. The Defence of Positions.—(1) From the German side. The

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results of the battles in April and May, 1917, were satisfactory on the whole to the Germans, except that the battering-ram tactics led them to distrust any work of fortification as a shell-trap. Ludendorf set to work to counteract this impression, and argued that if the strongest works could be destroyed the greater the necessity for making them more numerous and complicated, employing camouflage to deceive the attackers as to the principal line of resistance, and induce him to waste his ammunition. The front trenches need not be remade, but the craters joined up to form a line of advanced posts after the battle; (2) since the enemy tried from the first to capture the artillery, the guns, minenwerfer and machine-guns must be distributed in depth; (3) to diminish casualties the infantry must be disposed in greater depth, with fewer men in the front line, which was to be considered as an advanced position, while reserves were at hand without crowding the advanced lines. More mobility of both infantry and artillery should be attempted, especially by advancing into the less bombarded or more sheltered sectors. Finally, no ground was worth holding at all costs, an opportune and voluntary retirement would have no demoralizing effect, while the stubborn defence of unfavourable localities would destroy confidence in the commanders. It must be understood, however, that without the decision of superior authority the soldier's duty is always to preserve intact the ground entrusted to his defence. Under these circumstances the fight for the first line resolved itself into a fight for the first position. As to the employment of the reserves, he considered that too many infantry were often employed in counter-attacks; it was not necessary to engage the whole formation when part would suffice, and a counter-offensive should never be ordered unless the expected results would justify the anticipated losses. The artillery should economize ammunition by well regulated fire intended for destruction, instead of mechanical barrages which produced little result. In fact, the German doctrine had evolved very little since the end of 1916, the most important advance being that not the first line alone, but the first position as a whole was the object to fight for.

(To be continued).

A. R. REYNOLDS.

THE MILITARY ENGINEER.

IN the May–June, 1922, number of *The Military Engineer*, under the heading "With the Rank and Pay of a Sapper," a letter is quoted which had appeared in *The Infantry Journal* of March, 1922, from an officer who took part in the St. Mihiel offensive on 12th September, 1918. In front of the attack, in No Man's Land, ran the Rupt-de-Madt, a little stream of unknown depth and width, for which Division Orders required the engineers to build bridges in parts, carry them up to the jumping-off line the night before the attack, and go over the top with the first wave of infantry and place the bridges across the stream. In the attack the writer found only a small stream about thigh-deep, and that no bridges were necessary. After he had arrived at the first objective, in fog and smoke screen, he saw one of the sappers carrying his heavy load of

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bridging material, and enquiring where the river was to be found. He had carried his piece of the bridge through the stream and beyond it. Commenting on this incident, *The Military Engineer* writes :—

While it magnificently illustrates the spirit of the American soldier, it does more than that—it illustrates the need for an efficient distribution of Engineering Intelligence as distinguished from psychological, strategical, tactical, industrial and economical intelligence of the enemy, which are the particular spheres of the Military Intelligence Division of the General Staff.

Major Emery states that the Rupt-de-Madt was " a little stream of unknown depth and width—*unknown because the Germans had been in there for four years.*" As a matter of fact, a group of Engineer officers, working in the offices of the M.I.D., began in the fall of 1917 to compile data concerning streams, roads and bridges in enemy territory, giving dimensions, clearances and other data pertinent to transport operations. Another group working in the office of the Chief Engineer, but in close *liaison* with the M.I.D., made a series of studies on water supply. From both of these sources information concerning the Rupt-de-Madt was available at the time of which Major Emery writes. The water supply studies contained data as to volume of stream-flow and clearly indicated that the Rupt-de-Madt was a rather insignificant stream, particularly during the summer low-water stages. The other studies listed every bridge upon it and gave dimensions indicating the width of the stream.

All this data was printed and released for distribution as " Intelligence Documents," but for some reason they failed to reach the officers of G-4 and the Engineers whose duty it was to prepare engineer annexes to the Operations' plans.

Keen and able as they were on the " Order of Battle," the morale and similar information concerning the enemy, there were very few officers in the M.I.D. service who appreciated the significance of hydrologic and geologic reports or the possible effect on military operations of insufficient or faulty engineering reconnaissances. Then, too, secrecy and caution in collecting and distributing intelligence were often carried to such excesses as to defeat the very object of compiling the data. This appears to have been the case in the instance mentioned by Major Emery, for the necessary information was actually in the hands of the American forces, but unfortunately was locked up somewhere in idle storage.

F.E.G.S.

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ASSAULT BRIDGING.

A lecture delivered at the S.M.E., Chatham, on 20th Jan., 1921, *by* LIEUT.-COLONEL C. E. P. SANKEY, D.S.O. (late R.E.).

INTRODUCTION.

WHEN I was honoured by an invitation to lecture at the S.M.E. on the subject of bridging by Divisional Engineers during the advance of the British Armies in the latter part of 1918, I came to the conclusion that the most useful form my lecture could take would be the description of one bridging operation from the time when its possibility became apparent, through the various stages of reconnaissance and preparation, up to and including its actual accomplishment. For this purpose I have selected the bridging operations in connexion with the forcing of the Sambre-Oise Canal by the 1st Division on the 4th November, 1918, as I have a personal knowledge of the details of those operations, being at that time the C.R.E. of the Division.

From the point of view of actual bridging I am afraid that you may be somewhat disappointed; the obstacle to be bridged presented absolutely no engineering difficulties, though it is possible that some of the details in the designs of the bridges may prove suggestive. My real object, however, is to give you an idea of the preparations that have to be made and the difficulties likely to be encountered when carrying out an operation of this nature in the face of the enemy.

The telegraphic dispatch from G.H.Q., France, dated 9.5 p.m., 4th November, 1918, appearing in the morning papers of the 5th, contained the following paragraphs:—

> "This morning troops of the Fourth, Third and First British Armies attacked between the Sambre Canal at Oisy and the River Scheldt, north of Valenciennes. . . . . On the right of the attack the 1st and 32nd Divisions advanced to the assault in conjunction with French forces operating to the south of them. With great dash and gallantry, these two Divisions stormed the formidable obstacle presented by the line of the Sambre Canal and, in spite of strong resistance from the enemy, have pressed on to a depth of over three miles to the east of it. In these operations the 1st Division, under the command of General Strickland, having captured the town of Catillon, forced passages of the Canal opposite that place and near the lock, two miles south of it. At

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the latter point, assisted by Royal Engineers, the 1st Cameron Highlanders effected the passage of the Canal in six minutes. In the subsequent advance this Division captured the villages of Fesmy, Hautrève and La Groise, with 1,500 prisoners."

POSITION OF FIRST DIVISION.

As you all know, the German advance towards Amiens and the Channel Ports, in which they had made such large territorial gains in the Spring of 1918, was finally stayed, and, in July, the Allied Armies, in their turn, began to sweep forward towards the Rhine.

The 1st Division, after supporting the Canadians in their successful attack on the Drocourt-Quéant line on the 2nd September, was moved down to the right Corps of the British line, which was in contact with the French left.

It is not necessary for my present purpose to describe in detail the progress made by the Allied Armies during the months of September and October. Suffice it to say that the 1st Division, after the operations of the 17th and 18th October, was on the approximate line—Oisy–Rejet de Beaulieu-Mazinghien, and it was apparent that the passage of the Sambre-Oise Canal was a possible task for this Division in the near future; see *Diagram* A.

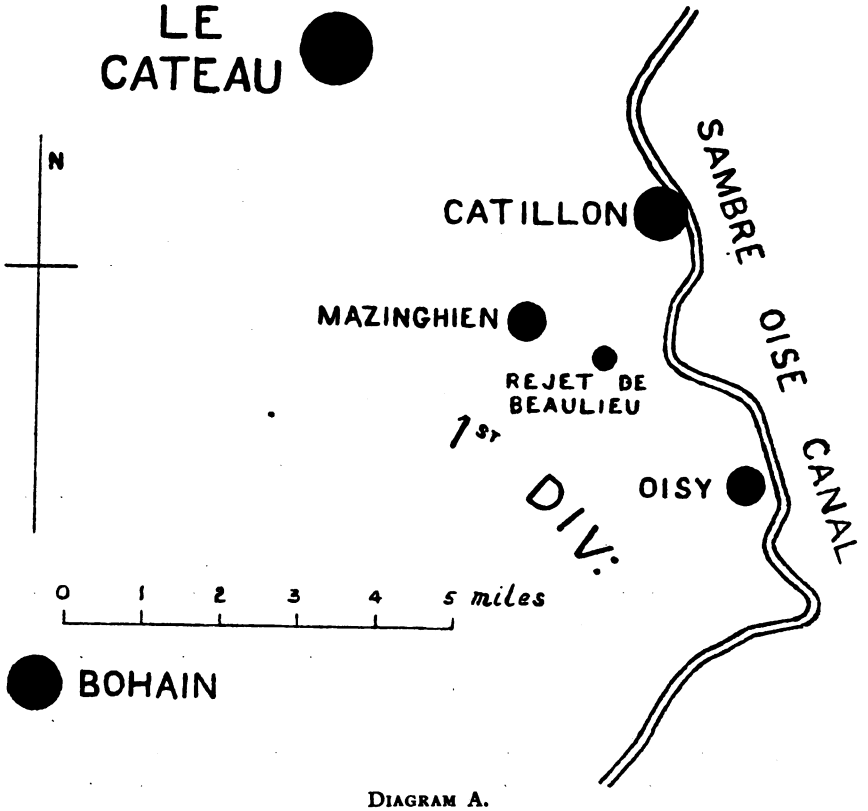

DIAGRAM A.

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Reconnaissance.

Reconnaissances were accordingly started with the following main objects :—

(*a*) The discovery of the available materials from which bridges could be constructed ;

(*b*) The collection of all possible information about the Canal, which formed the obstacle to be bridged.

Three points may be noted in this connexion :—

(i) Although all engineer officers do or should keep their eyes open and note in a general way the resources of a neighbourhood for various purposes, and although details of all the canals in the theatre of war were available in publications, yet these special reconnaissances were necessary to get down to numbers in the case of materials and to obtain the minutest local details in the case of this canal.

(ii) When these reconnaissances were started, the actual sites where the bridges would be required had not been determined, and, in fact, the whole operation had only just entered into the region of possibility.

(iii) All the officers and men of the Field Companies were already fully occupied with other work and it was difficult to find the personnel for these reconnaissances.

Reconnaissance for Bridging Material.

The reconnaissance for bridging materials was a safe and fairly simple operation, being conducted of necessity within our own lines. A miscellaneous collection of material was discovered or known to be available, in addition, of course, to the pontoon bridging equipment which always accompanies a Division, and which can be supplemented from that forming a Pontoon Park. Of the materials thus discovered, the following may be mentioned :

Timber of suitable scantlings, in ample quantities for the operation in question, and also miscellaneous stores, such as steel joists, wire rope and cordage, were found in Bohain. Bohain had been an important German Pioneer Park, and the accumulation of various engineer materials there was almost intoxicating ; my stores officer was so delighted with it that I had the greatest difficulty in getting him to come home, even for his meals.

Barrels of various sizes, from 26 gallons upwards, were found in the neighbouring villages. These were collected at the respective Headquarters of the three Field Companies composing the Divisional Engineers, and the coopers of these companies were turned on to bring them up to concert pitch ; a cooper is not a man who can be

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frequently employed at his trade on active service, but the men in question performed prodigies with these barrels.

It was known that a quantity of cork, made up into floating piers, would be available, but the exact amount was not known; and it may be mentioned here—though, strictly speaking, not a result of this reconnaissance—that 700 empty petrol tins were allotted to this Division just before the operation.

A considerable number of Berthon collapsible canvas boats were known to be at the Base; these were sent for, in case it should be decided to effect the crossing by a ferry service, rather than by a bridge proper. Eventually these boats were used as a stand-by only and were not actually employed.

The Germans had also kindly left in Bohain a number of portable bridges of 12-ft. and 15-ft. span, capable of carrying field artillery; see *Fig.* 1. Some of these were mounted on wheels and so could be readily transported, and they could also carry one or two bridges without wheels on their decks. It was realized that these bridges might be useful for crossing small streams, but their span was, of course, too short for the Canal itself.

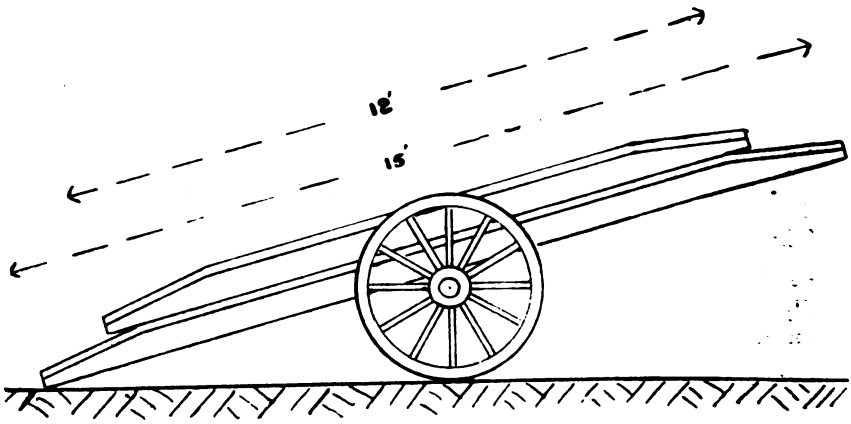

FIG. 1.

Most important of all, Bohain furnished a considerable number of light steel floats, used by the Germans in their assault bridging operations, notably when they attempted to cross the La Bassée Canal near Hinges; see *Fig.* 2. The following is an extract from the letter of the *Times* Special Correspondent, appearing in the issue of the 20th April, 1918:—

"From Paeaut Wood and opposite Hinges, large parties of Germans, covered by machine-guns, made rushes to the canal bank and tried to build pontoon bridges. The earlier rushes were completely broken and wiped out. At last the enemy

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succeeded in reaching the Canal and tried to throw a pontoon bridge, supported on "balloons," across. The pontoon was not long enough and the enemy party was terribly reduced by our rifle-fire."

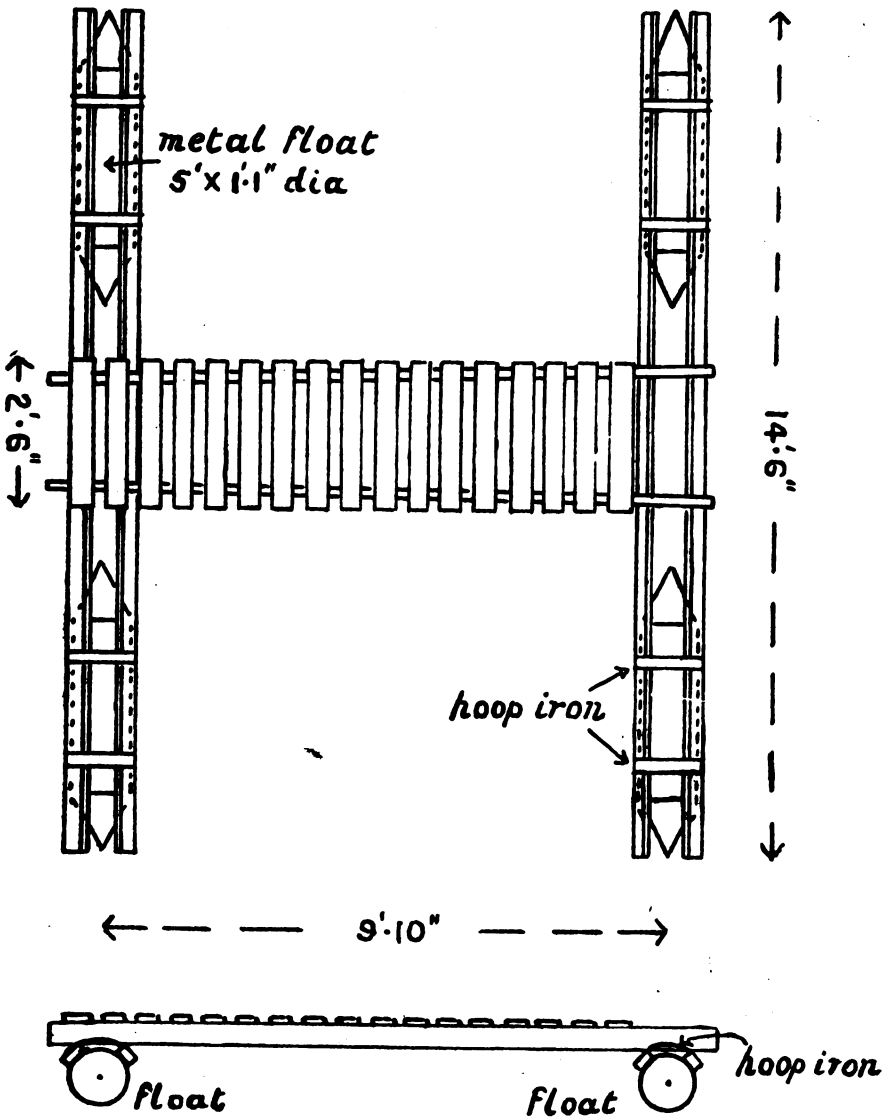

FIG. 2.

These light steel floats appeared so certain to be useful that wagons were sent to take them all away before they appealed to the cupidity of any other Division.

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RECONNAISSANCE OF THE CANAL.

Information about the details of the Canal itself was obtainable from various sources; General Staff publications and information issued by the Intelligence of the Staff of the IXth Corps provided certain details about the width and depth of the water in the Canal at the time of its construction, and about the height and slopes of the banks bounding it on either side; this information also established that the River Sambre flowed in several channels on both sides of the Canal, these subsidiary streams considerably increasing the obstacle

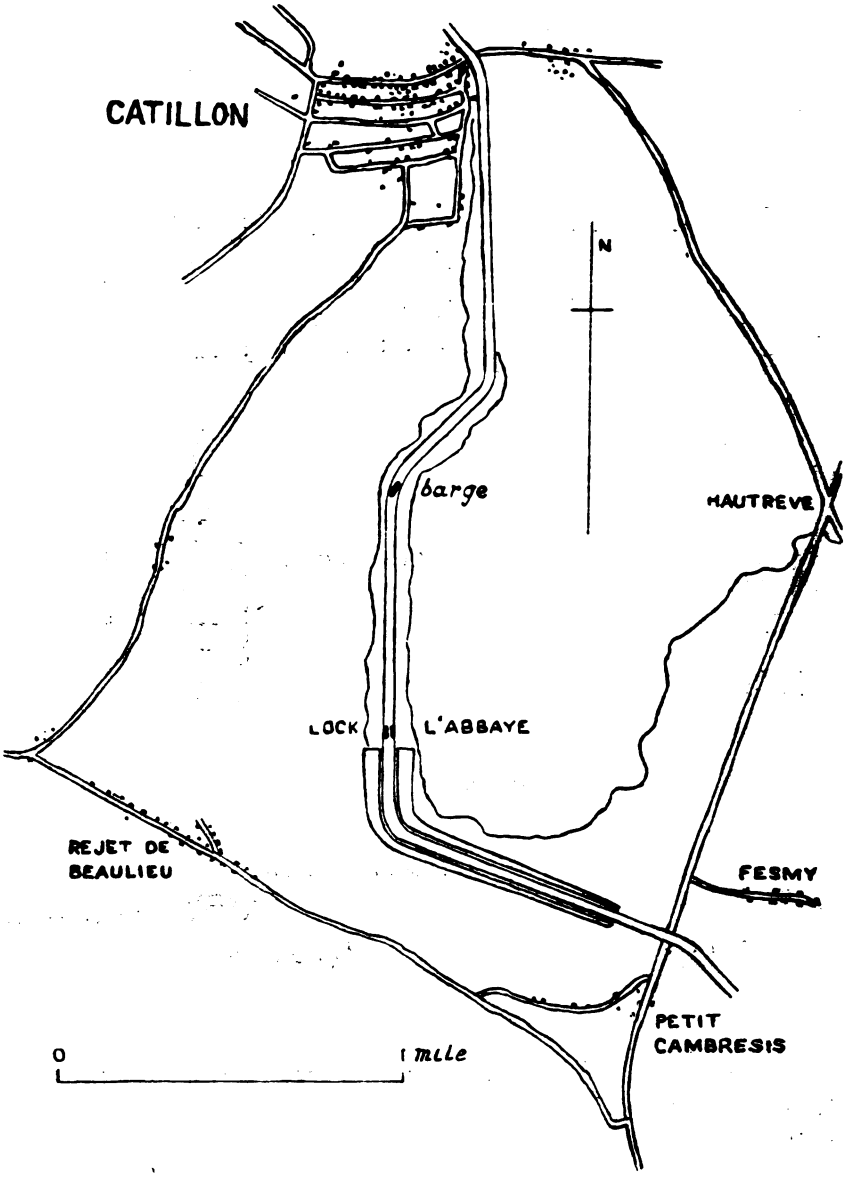

FIG. 3.

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from a bridging point of view. Details were also given of the bridges that had existed over the Canal in peace-time. See *Fig.* 3, which shows Catillon, the Canal and the main roads.

The information obtained in this way was necessarily of a somewhat general nature, and it was supplemented, checked and corrected by statements from prisoners and from civilians, of whom a few had been rescued from Catillon. The main facts established from these sources were that the existing bridges had been blown up and that the level of the water in the Canal had fallen.

A large number of air-photographs were examined most minutely and furnished much valuable information. Oblique air-photographs give a good general idea of the ground, but for actual measurements photographs taken vertically must be used.

Finally, there were the results of the reconnaissances carried out by officers and men of the Field Companies ; the difficulty of carrying out such reconnaissances can be realised when it is stated that both banks of the Canal were in possession of the enemy, and it was only due to the great gallantry displayed by these officers and men that so much valuable and accurate information was obtained. An interesting example of the possibilities of this form of reconnaissance may be mentioned. An attack was made by us towards the Canal on the 23rd of October, and a corporal and a sapper of the 26th Field Company were sent with that portion of the assaulting troops most likely to reach the Canal. During the fluctuations of this open fighting, our troops at one time reached the Canal, and, although, when our line had stabilized itself, both banks of the Canal were still in the hands of the enemy, yet this patrol had been able, during the fighting, to get up to the Canal and return with most valuable information. I am glad to say for this feat the corporal was awarded the D.C.M., and the sapper the Military Medal.

The main results of the reconnaissance of the stretch of the Canal opposite the front of the 1st Division may be summarized as follows (see *Fig.* 3) :—

(*a*) The bridge at Catillon had been blown up ;

(*b*) There was little to characterize any particular portion of the stretch from Catillon to the Lock, except that a sunken barge was in the bend ;

(*c*) The Lock at L'Abbaye was naturally of great interest, as the narrowing of the Canal here simplified the bridging problem ;

(*d*) Between the Lock and Petit-Cambresis there were two reservoir basins, one on each side of the Canal, each about twice as wide as the Canal proper at their northern ends, diminishing to points just north of the bridge at Petit-Cambresis. These naturally increased the difficulty of the bridging problem along this stretch.

(*e*) The bridge at Petit-Cambresis had been blown up.

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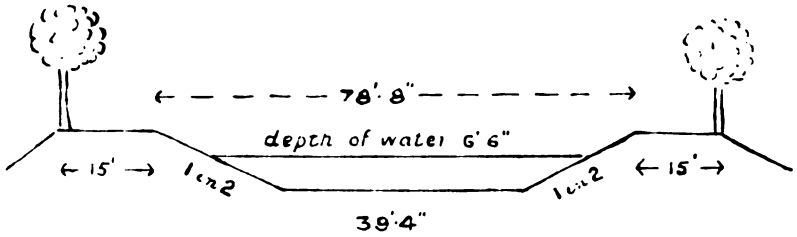
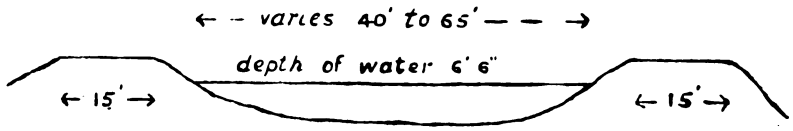
Diagrams of the normal section of the Canal were issued by IXth Corps Intelligence (see *Fig.* 4). The two lower sections in this *Figure* are referred to subsequently. The width of the Lock was given in publications as 17 ft. 1 in., and measurements from air-photographs showed that this dimension would not be largely exceeded.



Section issued by IX^Th Corps Intelligence



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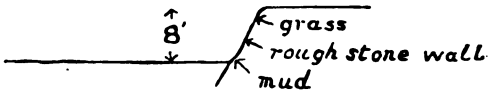
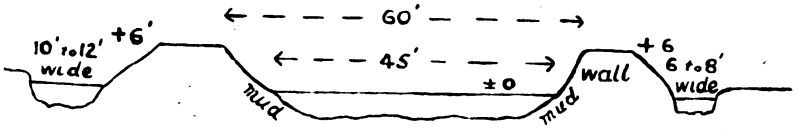
WEST EAST



Lt. Roberts' reconnaissance



Subsequent measurement.

FIG. 4.

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Although the various reconnaissances that have just been described were put in hand on the 19th October, it must not be supposed that they were completed on that day. In fact, in one shape or another, they were proceeded with up to the very eve of the operation, but the general results have been presented in this place for the sake of clearness.

Project for the Operations.

Returning to the chronological order, on the 21st of October, I held a conference with the three Field Company Commanders, at which the various possible means for crossing the Canal were discussed at length; the Company Commanders were asked to consider the problem thoroughly, and to submit projects for the bridging operation, both over the normal section of the Canal and also over the constriction at the Lock.

The attack of the 23rd October has been mentioned already; this attack carried the Division to within reach of the Canal from Catillon to Petit-Cambresis, though nowhere did we actually hold the western bank itself; the new line enabled the stretch of Canal along the Divisional front to be divided into three portions, each portion being allotted to one Field Company for the purpose of detailed reconnaissance (see *Fig.* 5).

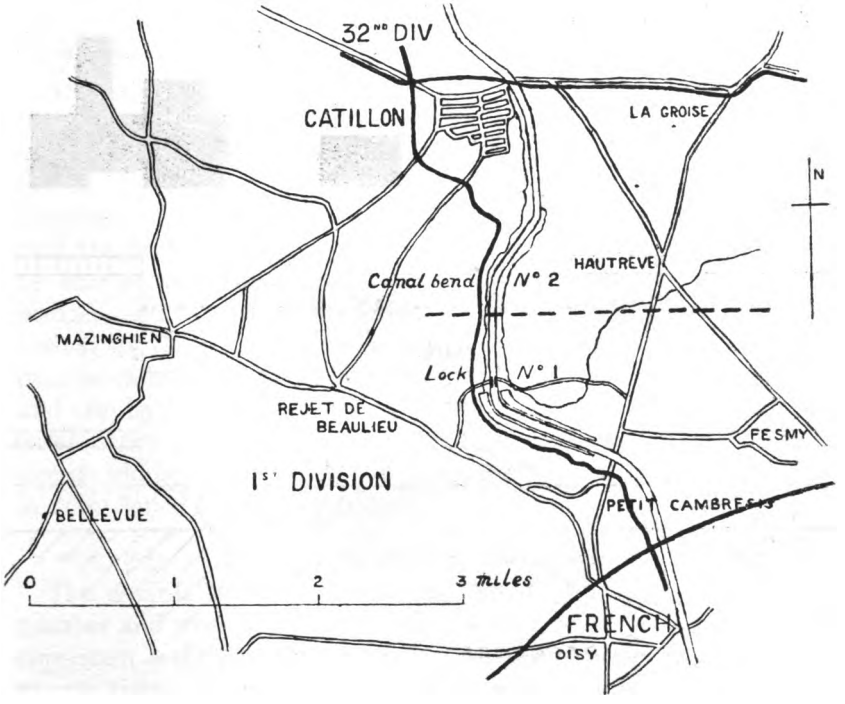

FIG. 5.

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On the 27th October a preliminary project for the operation of forcing the passage of the Canal was issued by the General Staff of the Division. This dealt with the general tactical aspects of the problem, but for the present purpose the most interesting portion was the selection of the sites for the actual bridging operations. These were two in number and were as follows :—

Crossing No. 1—at the Lock.

Crossing No. 2—at the Canal bend, about one mile south of Catillon.

DESCRIPTION OF THE BRIDGING SITES.

The fact that the bridging sites had been definitely selected made it possible to determine the types of bridges to be used at each. The two crossings were of entirely different natures.

Crossing No. 1, at the Lock, was a comparatively short span, with hard abutments. According to the information available, the span was 5·2 metres (17 ft. 1 in.), and by measurements on air-photographs it was made out to be not more than 19 ft.; it was measured subsequently to be 17 ft. The length available for bridging operations was 130 ft. according to information and about 190 ft. by measurement on air-photographs; actually, by pacing, it proved to be 180 ft. (see *Fig.* 6). The buildings on the east were nearly intact; but the house on the west was ruined; the towpath was higher than the ground level.

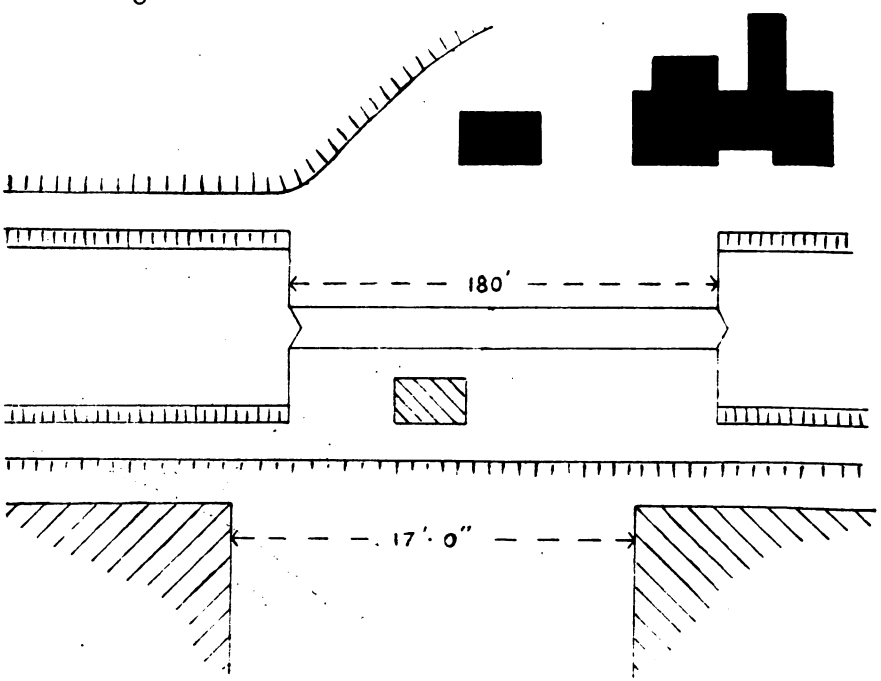

FIG. 6.

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Crossing No. 2, at the Canal bend, was a wet gap with apparently 40 ft. to 60 ft. of water, and the sides were muddy. A reconnaissance by Lieut. Roberts had established that there was a steep masonry wall on the east side, and, though he had not been able to see the western face, it was possible that this side also had a steep wall. The actual width of the water was found to be 45 ft., and the western face was much flatter than the eastern (see *Figs.* 4 and 5). The section by subsequent measurement is not strictly to scale; towpaths were about 15 ft. wide, but are shown smaller to allow room for the subsidiary streams.

Preparation of Material.

On the 28th of October a preliminary demonstration was given to the Divisional Commander of some experimental bridging material which had been prepared, and when his assent had been secured to the general principles proposed, another conference of Field Company Commanders was held, at which the responsibility of the several Companies was settled for the preparation of the material and for the erection of the bridges.

On the 29th October I issued a project in which the details of the bridging operations were given fully, including the various numbers and types of bridges to be used at each crossing, dimensioned drawings of each type of bridge and the allotment of the responsibility for the erection to the several Companies. It is not necessary to give this project here in full, but a general idea of the arrangements proposed is as follows :—

Although air-photographs and reconnaissance reports showed the existence of several foot-bridges and other means, such as the sunken barge, of crossing the Canal, it was not thought advisable to rely on the use of any of them for the operation, especially as they were stated to be prepared for demolition. It was also decided that the bridges to carry the first waves of assaulting troops should be carried up bodily from the assembly positions as completed bridges, and that no constructional work should be required on their arrival at their sites for erection. These assault bridges, as they may be called, were to be supplemented by other bridges for infantry and also by bridges to carry other forms of traffic; in the case of all those other bridges it was decided that constructional work at the site should be reduced to a minimum, and their details were designed in accordance with this principle.

Description of Bridges.

The assault bridges at Crossing No. 1, the Lock, were four in number and were designed as single-span bridges, as light as possible consistent with their being able to support five or six men on them at one time. They were fitted with a lever, and a pair of wheels, something like a fire escape, so that they could be launched from the

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near abutment without requiring anyone on the far side to receive them (see *Fig.* 7). These assault bridges were to be supplemented by four bridges, also designed to carry infantry in single file, but of stouter construction and without the special launching device.

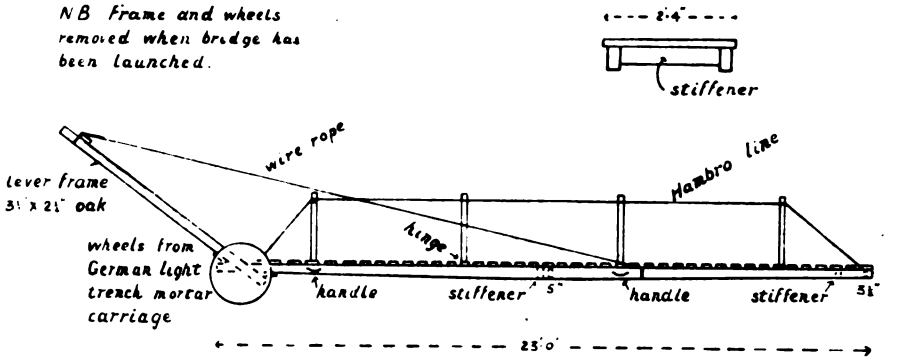

FIG. 7.

The assault bridges at Crossing No. 2, the Canal bend, were also four in number and were floating bridges carried on the German steel floats already mentioned; these, from their lightness and shape, seemed capable of producing the most portable bridge and the one best adapted for sliding over mud. This material was not used in accordance with the standard German method; it was taken to pieces and reconstructed in the manner here illustrated (see *Fig.* 8). The several bays of each bridge were hinged together in

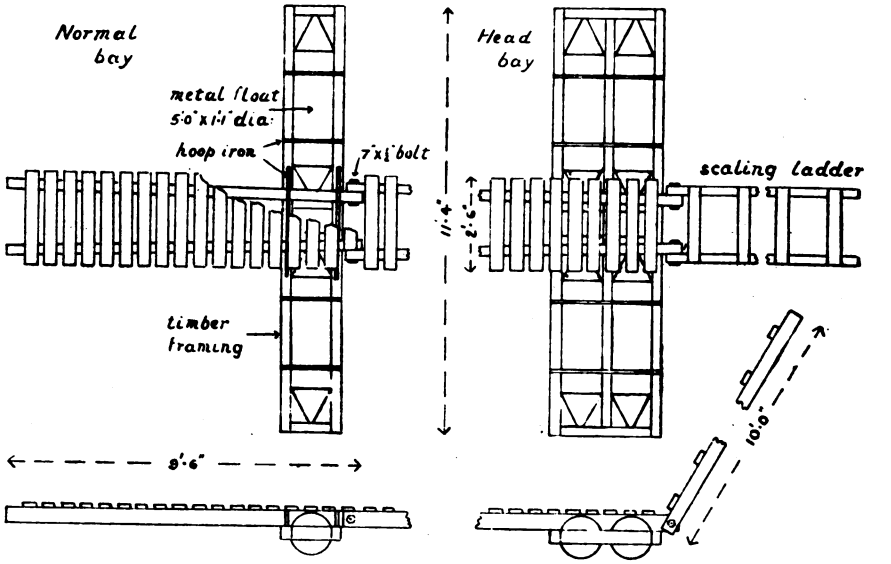

FIG. 8.

such a way as to give the maximum vertical flexibility, and the head of each bridge was provided with a hinged storming ladder, to enable the far bank to be scaled with ease. These assault bridges were to

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be supplemented by eight other floating bridges also designed to carry infantry in single file, but supported in different manners. Two were on cork floats, a standard equipment of separate roadways and piers, joining together with hooks and cleats (see *Fig.* 9).

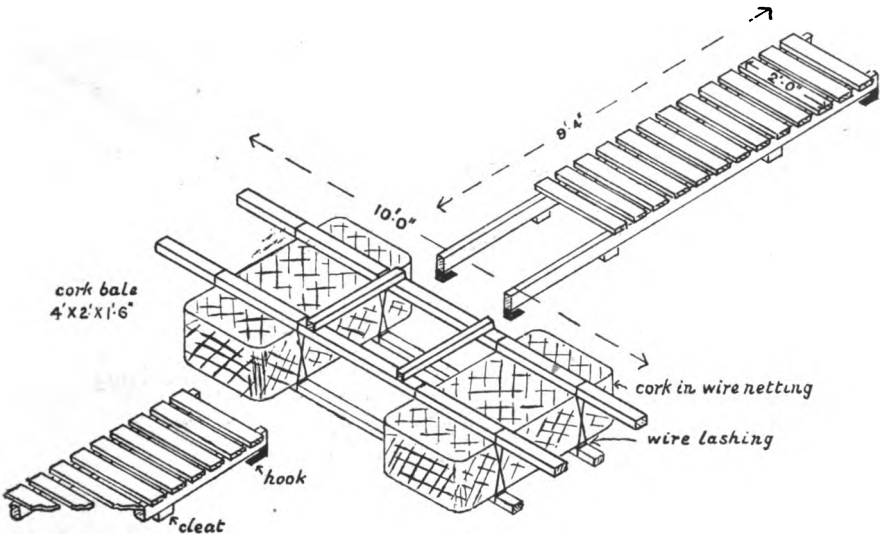

FIG. 9.

Four on barrels, in which one bay of roadway and one pier were made together, and formed into bridge similarly to the steel floats (see *Fig.* 10); the piers were not lashed with cordage, but were secured with hoop-iron.

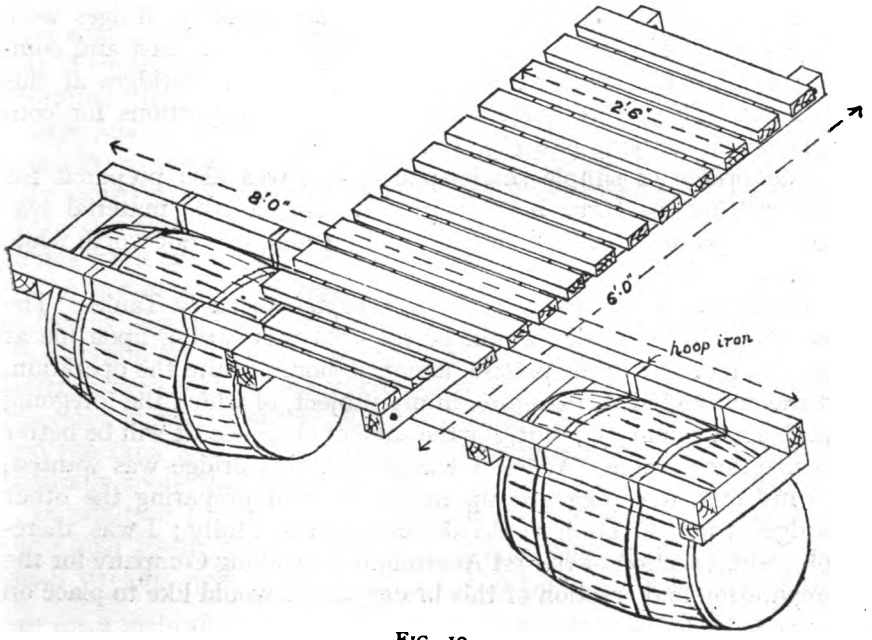

FIG. 10.

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And two on petrol tin floats, secured by wire lashings and hoop-iron (see *Fig.* 11).

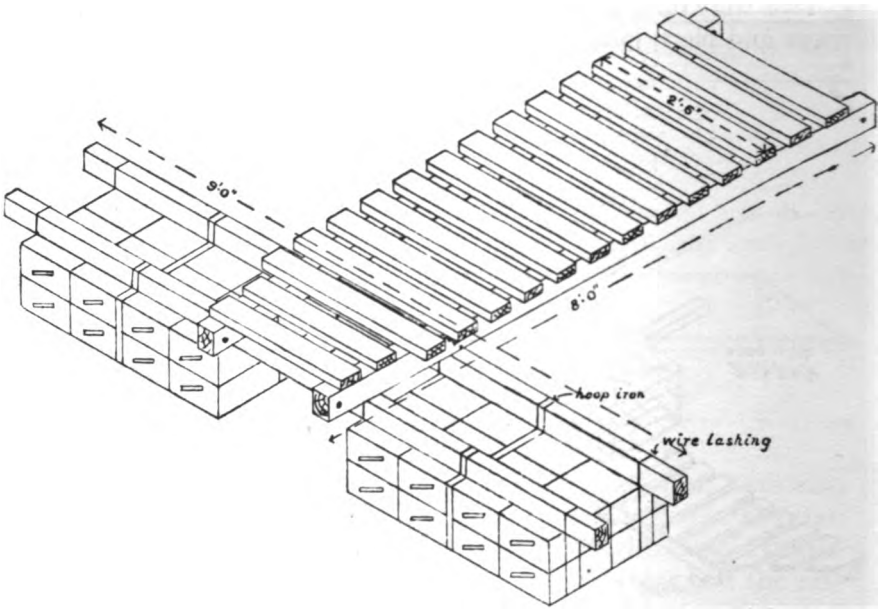

FIG. 11.

It was not proposed to erect any but bridges for infantry at No. 2 Crossing, but at Crossing No. 1, the Lock, a more ambitious programme was arranged.

Two bridges, each capable of carrying pack-transport or cavalry in single file, were to be erected when the infantry bridges were in position. These could also carry infantry two abreast and compensated for the smaller number of supplementary bridges at this crossing. They were made in two longitudinal portions for convenience in carrying (see *Fig.* 12).

One bridge of simple single-span design was also prepared for this crossing to carry horse transport, but, as the material was blown to pieces by a shell before it was erected, it is not worth while to describe it in detail.

Finally, at the Lock, was to be a bridge to carry Tanks. The fact that such a bridge would be required was sprung upon me at the last moment, to be precise, about 36 hours before the operation. It was not included, therefore, in my project, of which the foregoing has been a summary ; but, for the sake of clearness, it will be better to mention it here. When I learnt that this bridge was wanted, all my men were engaged up to the neck in preparing the other bridges, whose erection would also occupy them fully ; I was, therefore, lent a section of the 1st Australian Tunnelling Company for the preparation and erection of this bridge, and I would like to place on

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record that nothing could have exceeded the gallantry and loyal co-operation shown by the officers and men of this unit.

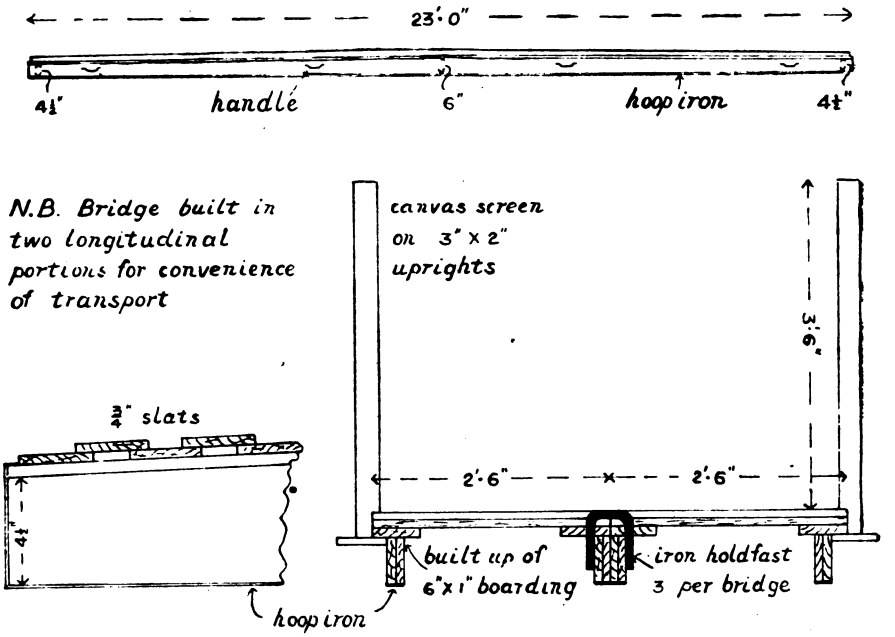

FIG. 12.

A bridge to carry tanks was, of course, far too heavy to be carried up complete, but it was designed in such a way that it consisted of two types of members only, steel joists and timber deck-planks, thus enabling a large party to be employed in its erection without fear of confusion; this is a good example of what may be called the Egyptian method of construction, in which simplicity of design and a large labour force result in a great economy of time. The shore-transoms or bed-plates were identical with the deck-planks, and the only constructional work required at the site was the prising-out of the coping-stones of the Lock, and the spiking-down of the wheel guides when the bridge had been erected (see *Fig.* 13).

The horse transport bridge at this crossing, already mentioned as having been destroyed, was only retained in the programme after the decision to include a tank-bridge, as a precaution in case the latter either could not be erected or was erected in an inconvenient place for horse transport. Luckily, neither proved to be the case, and the tank bridge took all the horse transport, for which it was naturally more than amply strong.

In addition to the bridges which have just been detailed, over the Canal itself, many subsidiary bridges were required over the small streams west and east of it. The spans were short and the

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design of these bridges presented no unusual features, but very careful organization was required to ensure that they should be properly erected at the right time and in the right place, and that the total capacity of these bridges should not be less than that of the bridges over the Canal itself.

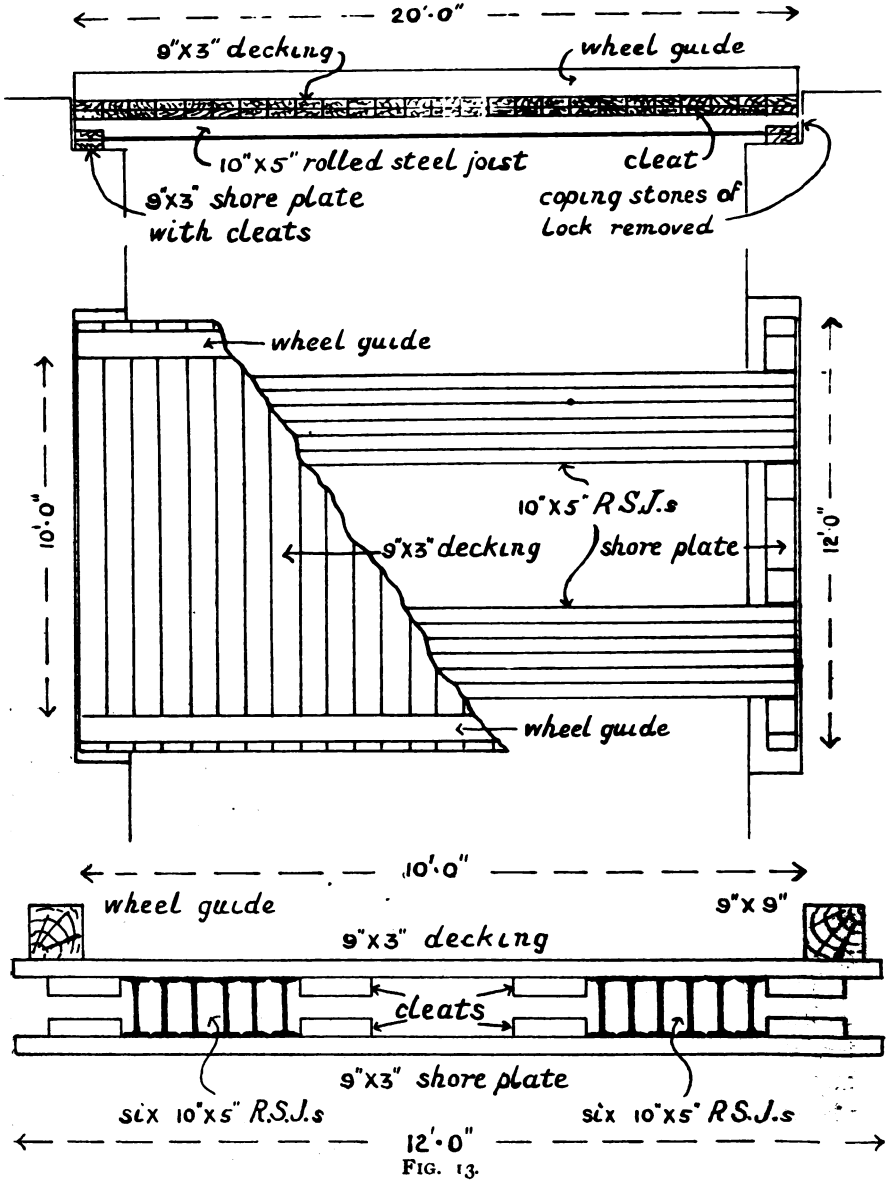

FIG. 13.

Twelve Berthon boats were also to be provided to run ferry services, above and below Crossing No. 1, and one at Crossing No. 2, in case the bridging proved a failure. These boats were all in readiness, but the necessity for their use did not arise.

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Supplementary Bridging Preparations.

The bridges so far described have had to do with the two crossings where the assault was to be made, but the projected operation, as a whole, demanded other bridging preparations. A subsidiary attack was to be directed against the town of Catillon (see *Fig.* 3), and a section of a Field Company was to accompany the force detailed for this portion of the operation, provided with materials for improvising foot-bridges over the Canal in that town. In the event of the attack being successful, the main-road bridge at Catillon would also need renewal, but with that, the 1st Division was not concerned, as the repair was to be carried out under the orders of the Chief Engineer of the IXth Corps. Again, the road crossing the Canal at Petit-Cambresis would have to be thrown open to traffic as soon as possible. Here a pontoon bridge to take horse transport was to be constructed by the 1st Division and also, possibly, a bridge to carry lorries; the renewal of the main-road bridge was to be in the hands of the Chief Engineer. It was also arranged that the Engineers of the 46th Division should throw three pontoon bridges over the Canal between the two crossings; these were not to be made until the operation had been in progress for some time and were intended to facilitate the forward movement of artillery in the case of success.

Technical Criticism of Bridging Methods.

To depart once more from chronological order, it will here be convenient to give the conclusions arrived at, in the light of experience, as to the suitability of the bridging methods employed, and so finish with technical details.

The assault foot-bridges, with special launching device for the Lock, were found to work very well (see *Fig.* 7). They were light, and could be carried easily by six men; no difficulty was found in up-ending them and in this position they could be run forward on their wheels or pivoted about them. It would have been better if the steel guys had been double, the two ends being secured to different points on the bridge; a difficulty was experienced with the first bridge launched, of which one of the guys was shot away.

The bridges on German steel floats were excellent, they were very light and the complete bridge was carried easily by two men per pier; the hinged joints, eccentric to the long axis of the piers, gave great vertical flexibility to the bridge and allowed it to be carried up and down banks (see *Fig.* 14).

Owing to the small height of the roadway above the water, this form of joint did not produce unsteadiness in the bridge when it was floating (see *Fig.* 8), in fact, these bridges successfully carried loads, such as stretcher-parties returning with wounded, for which they had not been designed. The storming-ladders, hinged to the

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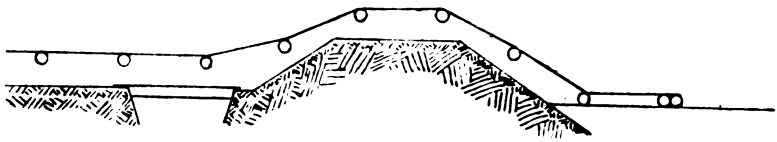
head of the bridges were perfectly efficacious, though, as a matter of fact, the far bank presented a smaller obstacle than had been anticipated.

The barrel bridges were also carried up and launched as complete bridges; owing to their greater weight they were not so easy to handle and required a larger carrying party. To enable these bridges to be carried over the canal bank they were also constructed with the same eccentric-hinged joint, which, in their case, introduced a ludicrous instability when floating.



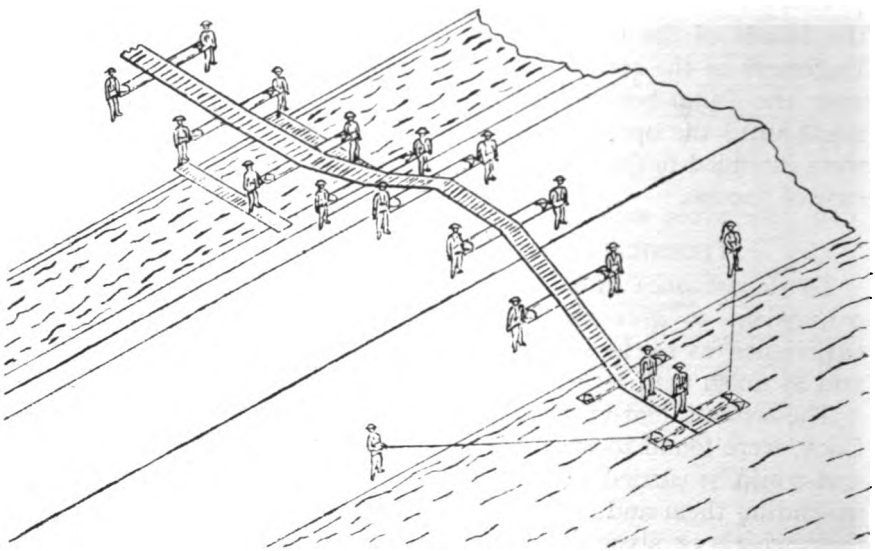


FIG. 14.

This was due to the greater height of the roadway above the water, so that the lever-arm of the hinged joint about the axis of flotation of the pier was sufficiently long to throw the whole bridge into a succession of "V's" as soon as a man put his weight on one end; as he moved forward each bay, the bridge re-adjusted itself into a fresh series of "V's" (see *Fig.* 15). This effect might prove a serious rival to the switchback at an exhibition, but was out of place in a military bridge. Luckily, this peculiarity was discovered during practice and was remedied by nailing tie-baulks across the gunnels of every three piers, after the bridge had been launched, and before it was opened for traffic, as shown in the top right-hand

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corner of *Fig.* 15. This made the bridge into a series of three-pier rafts and produced the necessary stability.

The bridges carried on petrol tins proved to be light and steady; they were also launched as complete bridges.

Bridges on cork floats are undoubtedly the best for comparatively permanent work, especially in positions exposed to enemy fire. They were, for example, the only kind of bridge that could be kept going at Nieuwpoort in 1917. They do not lend themselves to launching as complete bridges, however, and are, therefore, not suitable for use at the actual moment of assault.

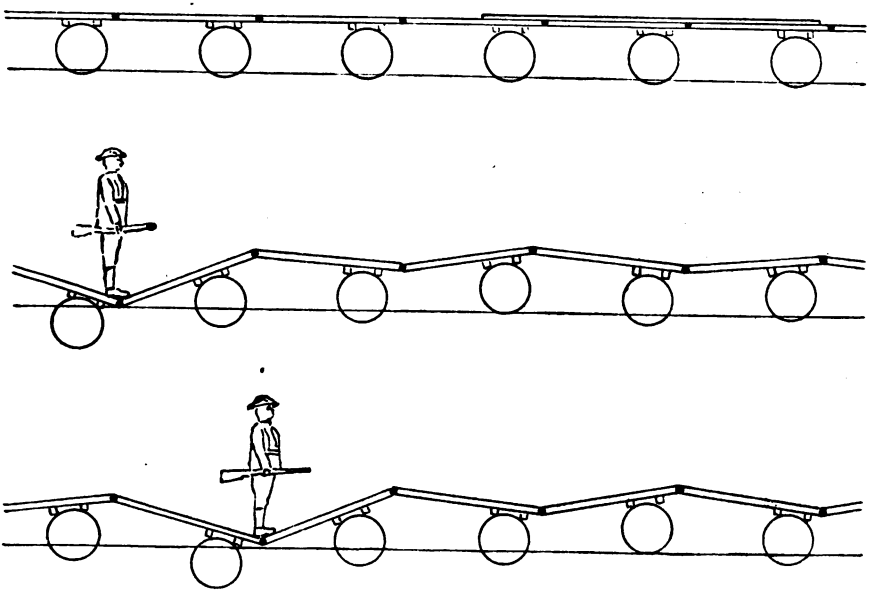

FIG. 15.

The tank bridge over the Lock proved very simple in construction and amply strong (see *Fig.* 13). It took two hours to make—a time which could have been considerably reduced if the materials could have been placed nearer to the site; they had to be at some distance, however, in consequence of the tactical situation, and also of the necessity for having the infantry bridges as near the Lock as possible.

PRACTICE.

As soon as the first few of the assault bridges previously described had been made, practices were carried out by the Field Companies responsible for their erection in conjunction with the Battalions detailed to cross over these bridges in the actual operation. A gap to imitate the Lock Crossing was easily made out of timber, as the depth was immaterial, and for the Canal bend crossing, a pond near the billets of the Field Company concerned was turned into a full-size section of the Canal by building revetted banks at each end.

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BRIDGE ASSEMBLY POSITIONS.

The next move in this bridging problem was to get the bridges as near as possible to the sites where they were to be used, and naturally all this movement had to take place at night.

The infantry and pack transport bridges for crossing No. 1 at the Lock were sent up in four wagon-loads, three pontoon and one G.S., the evening before the operation, that is on the 3rd November, and were taken to two forward dumps, whence they were carried by hand during the night to their final assembly position. The tank bridge for this crossing was sent up in six wagon-loads, three pontoon and three G.S., on the same night and carried forward similarly to an assembly position in rear of that occupied by the infantry and pack transport bridges. The horse transport bridge for this crossing was not sent up in advance.

The bridges for Crossing No. 2, at the Canal bend, were far more bulky and occupied 32 wagon-loads in all, 21 pontoon and 11 G.S., being sent up on three successive nights—1st, 2nd and 3rd November, dumped under trees and hedges and in orchards some 500 or 600 yards from the Canal and covered with camouflage material.

The assault bridges were put together and carried forward to their final assembly position on the night of 3rd November.

BATTLE DISPOSITIONS.

The battle dispositions of the 1st Division, as far as they affect this account of the bridging operations, were briefly as follows (see *Fig.* 5) :—

The artillery and machine-guns were disposed so as to bring a heavy barrage on the line of the Canal at zero hour. The 2nd Infantry Brigade was detailed to force the passage at Crossing No. 1, at the Lock, the 409th Field Company being responsible for the bridging operations, with the section of the 1st Australian Tunnelling Company for the tank bridge. The 1st Infantry Brigade was detailed for Crossing No. 2, at the Canal bend, the bridging being in the hands of the 23rd Field Company. The 3rd Infantry Brigade found the troops for the attack on Catillon, and with them was a section of the 26th Field Company, with a wagon containing a suitable selection of timber for improvizing foot-bridges. The remainder of the 26th Field Company was in reserve in the hands of the C.R.E., and was assembled in a position of readiness some three miles from the Canal. This Company had with it all the pontoon wagons of the three Field Companies, fully loaded with their pontoons and trestles, for the bridge at Petit-Cambresis, a wagon containing the material for the horse transport bridge at the Lock, and a German wheeled portable bridge carrying two others on its back. Advanced Divisional Headquarters were at Bellevue.

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Summary of the Operation.

We have now arrived at the 4th November, the day of the attack. Before the events at the two crossings are described in detail, it seems advisable to give a *résumé* of the whole operation. Zero hour was at 5.45 a.m., and about 7.30 a.m. news was received at advanced Headquarters that the passage of the Canal had been successfully forced at both crossings and that the 1st and 2nd Brigades were advancing to their objectives. Shortly afterwards orders were given to the 26th Field Company to move forward, supplemented almost immediately by another order for a section of that company to proceed to the Lock to reinforce the 409th Field Company, which had been seriously weakened by casualties, taking with it the wagon containing the horse transport bridge and the German portable bridges. A report having been received about 10 a.m. that the site of Petit Cambresis Bridge had been captured by the 2nd Battn. Welch Regt., the 26th Field Company was ordered to reconnoitre this site and shortly afterwards to begin making the pontoon bridge there for horse transport. The operation at Catillon having been successful, the section of the 26th Field Company engaged there was returned to its Company and assisted it in the pontooning. Shortly before 6.30 p.m., the infantry having reached their objective, the following orders were issued:—23rd Field Company to withdraw, leaving a maintenance party at Crossing No. 2. 26th Field Company to continue work on the bridge at Petit-Cambresis and to maintain the bridges and horse transport route at Crossing No. 1. 409th Field Company and Section 1st Australian Tunnelling Company to withdraw.

Zero Hour.

I now want you to picture the state of affairs in the neighbourhood of the Canal during the early hours of 4th November. The Germans, with their machine-gun posts every 50 yards or so along the east bank of the Canal, and, in some cases, on the western bank as well, must, no doubt, have been keeping an anxious watch, feeling sure that an attack was bound to come sooner or later, though not knowing the day nor hour. Our own infantry, crouching down in the dark in their exposed assembly positions—for the days of assembly trenches disappeared with the advent of open warfare—and the sappers silently engaged in putting together their bridges and cutting gaps in the hedges through which to rush them up, must have wondered what the morning would bring for them. As the first faint light of dawn became visible, providentially veiled by a white mist, our men stood to, all their preparations ended. The sappers stooped down to pick up their bridges and punctually at the appointed hour the artillery and machine-gun barrage came down like a crash of thunder on the line of the Canal. The intensity of the fire prevented

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the Germans from putting up their heads for a few minutes and in those few minutes our men had picked up their bridges and had carried them down to the Canal. Let us see what happened to them there.

FORCING OF THE CANAL AT THE LOCK.

At the Lock the great possibilities of bridging must have been apparent to the Germans and it was not more than a minute or two before their counter-barrage fell in its vicinity. As it was held by their own men they could not actually shell the Lock itself, and the line of their barrage was about 50 yards to the west of it, though a few shells were dropping short (see *Fig.* 16). To a certain extent our men were already within this line, but still they suffered very heavy casualties. The bridge parties were divided into two groups, northern and southern, and at 5.49, the northern group with two assault bridges and other smaller bridges had encountered a small stream, which was bridged with two of the smaller bridges; one assault bridge had crossed and the second following when the whole party of this second bridge was put out of action by a shell; the first assault bridge and one small bridge reached the stream immediately west of the Lock at 5.50. Here it was evident that, owing to obstructions—such as roots, fallen trees and barbed wire—it would not be possible to find places where two of the smaller bridges could span the stream side by side, and orders were sent for the supplementary bridges, designed for the Lock itself, to come forward at once. Examination showed that the bank south of the ruined house was covered with barbed wire, whereas the bank north of this point was free from it and also afforded a suitable site for placing two of the supplementary bridges side by side; at this place, moreover, the surface of the Lock was clear of debris and so it was selected for the passage.

During this examination of the Canal bank two of the smaller bridges of the southern group arrived and were placed over the stream by men wading up to their waists, and two others arriving shortly afterwards were used in conjunction to form a single crossing.

While this was going on, some infantry scrambled over the bridges and the stream and silenced the enemy post in the ruined house which had been causing a considerable number of casualties by bombs. About five minutes past six, two of the assault bridges had been taken up on top of the lock and their wheels and launching levers were fixed; one of the guys of the first bridge was shot away, but, by lowering it gently, it was put into place at ten minutes past six, and Major Findlay, Commanding the 409th Field Company, followed by two of his N.C.O.'s, crossed over it and rushed a German machine-gun post on the eastern side. The infantry now began to cross and with them smaller bridges for the stream east of the Lock. Other

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bridges also arrived for the Lock itself and by half-past six, there were six bridges over the Lock in addition to a German foot-bridge made out of ladders, which was found and utilized. This completed the

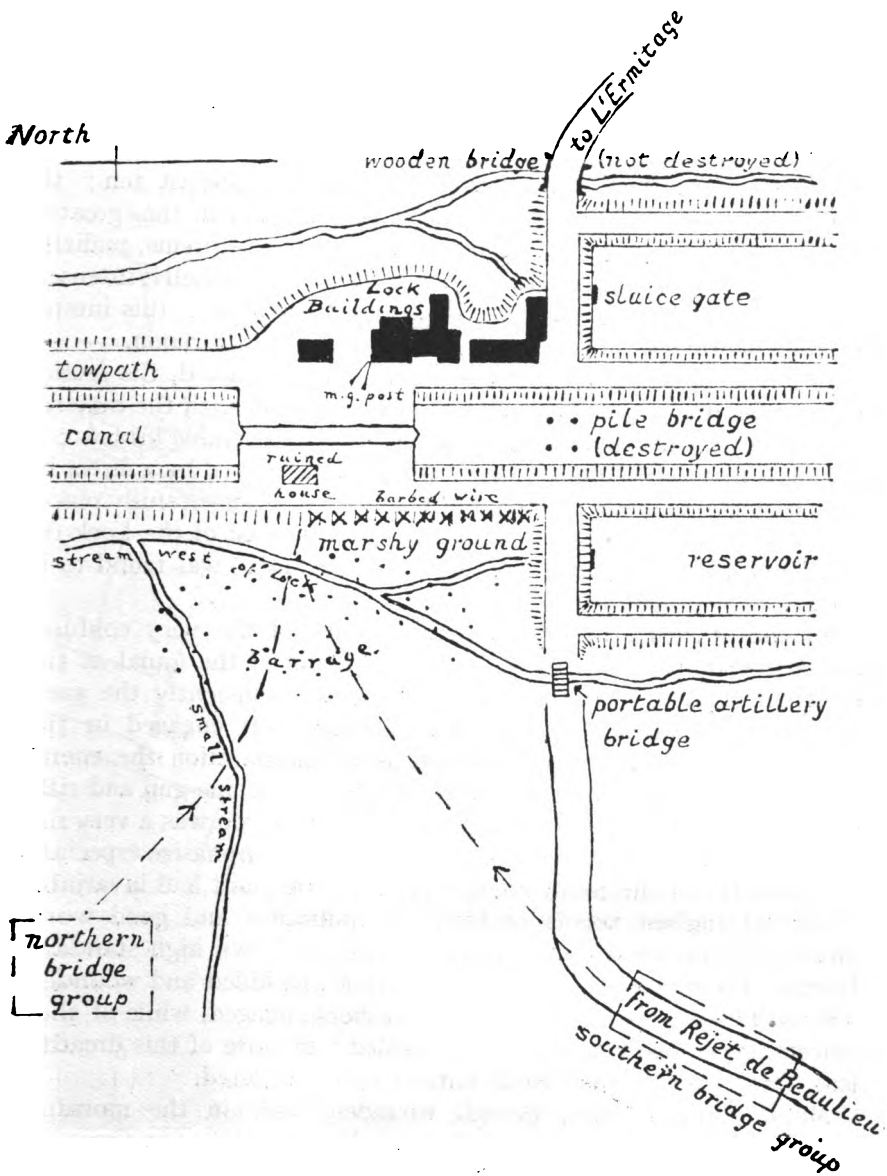

FIG. 16.

programme of infantry bridges, as two of those intended for the Lock had had to be used over the stream west of it. The remnant of 409th Field Company—for casualties had been very heavy—were collected in the cellars of the Lock buildings for a brief rest.

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About 7 o'clock the work began again and the pack transport bridges were carried up from a distance of 500 yards, in which work great assistance was given by the drivers of the pack animals which had arrived by this time, and also by men of other units; at half-past eight these bridges had been completed, including screens, and the pack animals began to cross over; as the 409th Field Company had completed the task allotted to them, they were withdrawn to shelter in the vicinity.

About this time the first steel joists for the tank bridge reached the Lock, and this bridge was completed at half-past ten; the successful accomplishment of this task demanded the greatest gallantry on the part of the Australians, for the Germans, realizing that their men no longer held the Lock, had begun to shell it intensely with 8-in. and other heavy shells at about 9 o'clock; this intense shelling continued till about half-past three in the afternoon.

About the time that the tank bridge was completed, the section of the 26th Field Company arrived near the Lock with the material for the horse-transport bridge and the German portable bridges; as has been mentioned already, the former was destroyed by a direct hit by a shell before it was erected, but the latter were successfully placed over the stream west of the Lock; the stream east of the Lock did not require bridging, as the original wooden bridge was found to be intact.

In endeavouring to give a clear account of the very confused happenings which occurred during the forcing of the Canal at this crossing, I have, perhaps, failed to indicate sufficiently the great bravery demanded from the men of every unit engaged in this operation, resisted as they were by every preparation the enemy could make in the way of obstacles, artillery, machine-gun and rifle-fire, but there is no doubt that this successful action was a very fine feat of arms. It is perhaps natural for me to emphasize especially the gallantry of the 409th Field Company; this unit had invariably given the highest proofs of bravery, endurance and good work, but on this occasion they surpassed even their own high standard. During this action they incurred casualties, in killed and wounded, amounting to 50 per cent. of their numbers engaged, while of their officers, every one was killed or wounded; in spite of this dreadful loss, they stuck to their work until it was completed.

Major Findlay, who, though wounded early in the morning, remained at duty until nightfall, was given the Victoria Cross for his extreme gallantry during this operation.

CANAL BEND CROSSING.

We will now see what happened at Crossing No. 2, at the Canal bend, where the 23rd Field Company, under the command of Major

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Smith, was responsible for the bridging (see *Fig.* 17, which shows the assembly position, with the routes of the bridges from their concealment up to the Canal.)

At 5.45 a.m. the barrage fell on the line of the Canal and the assault bridges, some 250 or 300 yards from it, were lifted and carried forward. They reached the western bank of the Canal five minutes

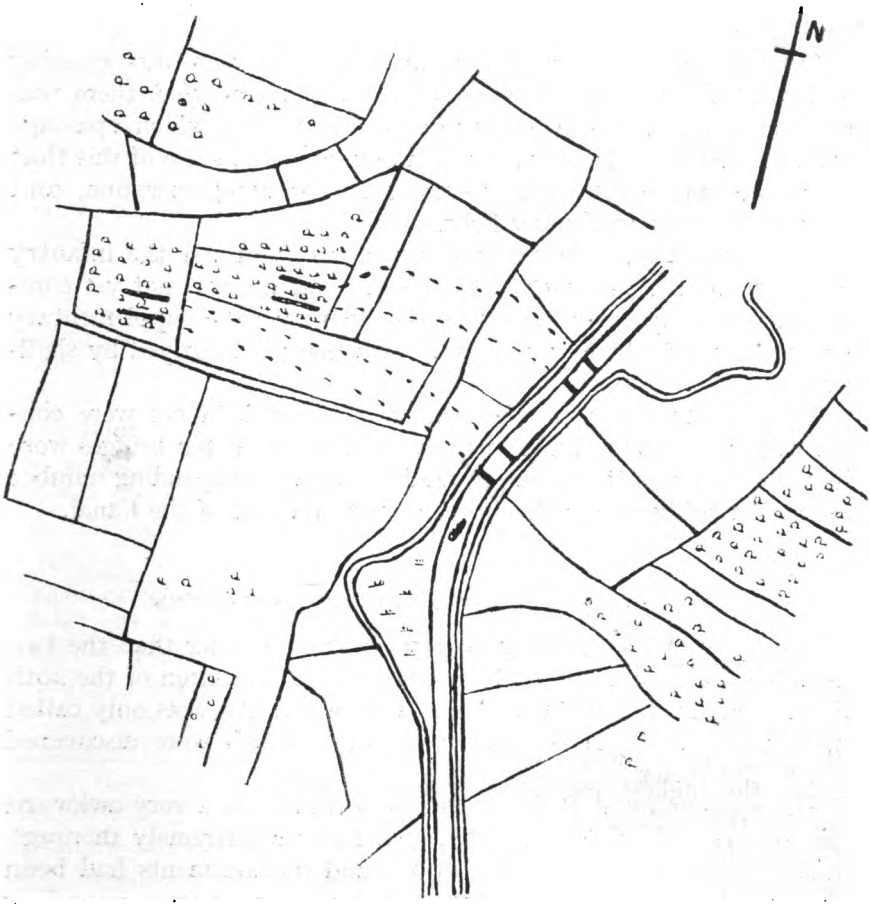

FIG. 17.

later at 5.50 a.m.; the party with the southern-most bridge found a German machine-gun post of five men on the bank, just where the bridge would be launched. Sergt. Cook, of the 23rd Field Company, who was in command of this bridge party, rushed this post single-handed, killing three and capturing the other two. The bridges moved forward up the Canal bank and down the other side, and entered the water.

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At 5.54, nine minutes after zero, and four minutes after arriving at the Canal bank, Sergt. Cook's bridge was in position and the 1st Camerons were crossing ; one minute later the other three assault bridges were also in position.

Each assault bridge carried two sappers at its head, who threw up the storming ladder on arrival at the far bank, went ashore and anchored the bridge. These leading sappers then formed themselves into a party and captured two enemy posts behind the east bank of the Canal.

In addition to the physical differences between this crossing and that at the lock, there was the tactical one that there was nothing to indicate to the enemy the precise point at which a passage would be attempted ; it was presumably in consequence of this that there was no hostile shelling during the bridging operation, and casualties were surprisingly light.

Although the assault bridges were in position and the infantry crossing rapidly, the work of the Field Company was not yet completed ; the sappers returned to the dump for the supplementary bridges, two of which were found to have been destroyed by shell-fire.

These bridges were much heavier and the distances were considerable ; consequently, it was not until 9.15 that ten bridges were in position across the Canal, in addition to a corresponding number of smaller bridges over the streams west and east of the Canal.

SUPPLEMENTARY BRIDGING OPERATIONS.

The story of the bridging operations at sites other than the two assault crossings can be told very briefly. The Section of the 26th Field Company, engaged in the attack on Catillon, was only called upon to repair some German foot-bridges which were discovered practically intact.

The pontooning at Petit-Cambresis proved to be a very awkward job for the 26th Field Company, owing to the extremely thorough manner in which the original bridge and its abutments had been blown up by the Germans and the marshy nature of the surrounding country.

Eventually, a trestle bridge was erected over a huge crater in the road and a pontoon bridge placed well south of the alignment of the original bridge, with long ramps leading down to and up from it.

A lorry bridge had also been meditated here, but, when the site had been reconnoitred and the amount of work involved realized, it was not thought necessary to undertake it, as the semi-permanent bridge for this site, to be erected by the Chief Engineer of the IXth Corps, would shortly be in hand.

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Conclusion.

In conclusion I would like to give some idea of the amount of material preparation required for an operation of this nature; the total number of bridges, prepared or erected, and designed to carry loads from infantry in single file up to tanks, was 133, and their total length was 2,414 feet, or nearly half a mile, as shown in the following tabular statement :—

Summary of Bridges prepared or constructed.

Unit by which used.	*No. of Bridges.*	*Designed for Load.*	*Length in Feet.*	*Foot run of Bridge.*
409th Fd. Co., R.E. ...	8	Infantry, single file	23	184
	8	,, ,, ,, ...	16	128
	8	,, ,, ,, ...	12	96
	2	Pack Transport	23	46
	2	,, ,, ...	16	32
	2	,, ,, ...	12	24
23rd Fd. Co., R.E. ...	4	Infantry, single file (steel floats) ...	81	324
	2	,, ,, ,, (petrol tins) ...	72	144
	4	,, ,, ,, (barrels) ...	66	264
	2	,, ,, ,, (cork) ...	60	120
	36	,, ,, ,, (single-span) ...	10	360
	48	,, ,, ,, (ladders) ...	10	480
26th Fd. Co., R.E. ...	1	Horse transport	21	21
	1	,, ,, (portable artillery)	15	15
	2	,, ,, ,, ,,	12	24
	1	,, ,, (pontoon equipment)	51	51
	1	,, ,, ,, ,,	81	81
1st Austr. Tunn. Co., A.E.	1	Tanks	20	20
	133			2,414 ft. or nearly half a mile.

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THE TWYDALL REDOUBTS.

By COLONEL H. D'A. BRETON, (late R.E.)

THE reference in *R.E. Journal* for May to the Twydall Redoubts and Lord Sydenham raised a suspicion that you might possibly care to know the history of these works.

They are the relics of a project prepared by a civilian draftsman under the instructions of the officer who was then the "Station Officer" for Chatham at the War Office. The design consisted of a continuous gun parapet with 10-ft. command and a detached infantry redoubt on each flank.

We had by then adopted the glacis slope for Port Defence batteries because of the disruptive effect of heavy Naval projectiles on steep exterior slopes. The principle was applied at Twydall because of the effect produced on some minds by the Russo-Turkish War, and the defence of the Gravitza redoubts, from which it was concluded that the only defence necessary was rifle fire and the addition of passive obstacles was therefore obsolete.

Lord Sydenham was at the time advocating the substitution of "provisional" fortification, which could be applied when war appeared probable, for "permanent" fortification, which was apt to be out of date when wanted, and the construction of the northern redoubt was sanctioned. The contractor was given an entirely free hand, the object of the experiment being to ascertain the least time required for the construction of such a work. The redoubt was begun and completed in three weeks. The cost was, of course, not of the "essence of the contract"!

I visited the work on completion and judged it untenable. A man standing on the terreplein was visible over the parapet towards the right front, there being no attempt at defilade, and I misdoubted the capability of the concrete shelters to stand the shell of the light field howitzer when the howitzer was improved, as it was bound to be, within a few years.

After Chatham affairs were transferred to me, I had to get out the detailed plans for the southern redoubt, and tried, so far as possible, to remedy some of the defects without altering the general design or trace; but I never believed in the design of either redoubt, and remained curious to know how they would stand the test of war. It was therefore interesting to read that the chain of half-a-dozen super-Twydalls, with two-tiered casemates, at Kiao Chao were all carried by the Japanese in one night.

I know the histories practically of all the Chatham works, with amusing instances of how-not-to-do-it.

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AN OUTLINE OF THE EGYPTIAN AND PALESTINE CAMPAIGNS. 1914—1918.

By MAJOR-GENERAL SIR M. G. E. BOWMAN-MANIFOLD, K.B.E., C.B., C.M.G., D.S.O., *p.s.c.*

(*Continued*).

CHAPTER III.

THE WESTERN DESERT OPERATIONS AGAINST THE SENUSSI.

THE WESTERN DESERT OPERATIONS AGAINST THE SENUSSI.—Turkey tries to harass Egypt from the west—The Oases of the Western Desert—The Coastal Plain—Senussi Attack on Sollum—Action at Hazalin, December, 1915—Action at Agagir, February, 1916—Rescue of the Tara prisoners.

AFTER the fiasco of the attack on the Suez Canal in February, 1915, the Turks became fully occupied by the Allied landings in Gallipoli and the British advances up the Tigris. They could then spare no more troops for Sinai to move against Egypt from the east. So they looked to Italian Tripoli to find a means to harass Egypt from the west. (See *Sketch Map* 1).

West of the Nile Delta, the desert is relieved by a narrow coastal plain, inhabited and sparsely cultivated by the Bedouin Arab tribes. This plain was traversed by a standard-gauge railway from Alexandria for 100 miles to Daaba, and thence there existed a cleared track, called the Khedivial Motor Road, to Matruh, Barrani and Sollum (small harbours on the coast). This plain provides camel grazing; it carries a small scrub; the ground is friable and dusty in summer and becomes intensely sticky after rain, which is frequent between December and March. A rocky escarpment rises from the plain on the south, and a table-land of limestone hills and hard desert about 180 miles wide, meets near Siwa the limitless sand dunes of the Libyan Desert. Siwa is the gateway to a series of oases (Baharia, Farafra, Dakhla, Khargha) which lie about 100 miles west of the Nile valley. That cultivated valley presented a frontier, some 800 miles long, exposed to raids from these oases.

The Mohammedan nonconformist sect, known as the Senussi, was founded by a religious leader in 1835. Its centres of influence lay mostly in the great oasis of Kufra and at Siwa, and its outlet to civilization was through Tripoli. The sect had many adherents in Egypt, too, particularly in the Fayum, Behera, and in the coastal plain. Under the Turks, the Senussi were quiet, but when the Italians took over Tripoli and restricted their caravan trade, they became hostile and supported the Turkish cause. They therefore were susceptible to fresh Turkish propaganda.

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In the spring of 1915 Jafar Bey, or Pasha, was sent to the Senussi with arms, and bearing a letter from the Kaiser to their leader, Sayed Ahmed. The Tripoli coast had convenient coves for landing, and further consignments of munitions and money were conveyed by submarine from Greece. The movement took form in May; the Senussi tribesmen were drilled, and furnished a tolerably regular force, which by the autumn of 1915 numbered about 5,000 riflemen, with a few machine-guns and 10-pdr. mountain artillery with camel transport. In November, the Senussi displayed open hostility. They carried off captive the shipwrecked crew of H.M.S. *Tara*, which had been torpedoed near Sollum; and on 6th November, they shelled Sollum itself, and raided in the coastal plain.

This movement of the Senussi alarmed the authorities in Egypt. Our deadlock in the Dardanelles had reacted unfavourably there. Egypt had been drawn on for troops, for stores, and for native labour, and she was encumbered with the wounded. The Egyptian began to give ear to the Senussi agitation, supported as it was easily from within by strong Turco-German propaganda. A rising in Egypt was feared.

Action at Hazalin.—General Sir John Maxwell withdrew the Egyptian garrisons from Sollum and Barrani, but held on to Mersa Matruh and Daaba. A composite force of British, South African, New Zealand and Indian troops, under Major-General Wallace, was assembled at Matruh to cover the western flank of the Nile Delta. The Senussi occupied Sollum, moved on to wells near Matruh, and raided the Daaba–Alexandria railway. General Wallace drove them off on 13th December, and again on 25th, but was not able to follow up. The Senussi forces withdrew to Hazalin, about 25 miles south-west of Matruh. More troops were concentrated, and on 23rd of January, 1916, General Wallace set out from Shola (16 miles west of Matruh) to engage the enemy. The night had been wet. Our force marched at 0600 hours in two columns:—

Right Column.—One squadron, Notts Battery, R.H.A.
Three battalions (15th Sikhs, 2nd S. A. Regt., 1st Batt. N. Z. M. Brigade.) These moved by compass-bearing, direct on Hazalin.

Left Column.—Six squadrons, M.G. Section, Battery, H.A.C.
On the left front of the infantry.

Reserve.—Two troops Yeomanry, half-battalion, Royal Scots.

The enemy were encountered about nine miles out. They held a front of some 1½ miles, approached by quite open ground; and a heavy mirage rendered observation difficult. At 1000 hours the 15th Sikhs advanced to attack, supported by the other two battalions. The enemy steadily fell back for three miles, and about noon began seriously to threaten our right flank. About 1330 hours the mounted troops also were being pressed until infantry

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got up to support them. But, by 1530 hours, the infantry had overrun and burnt the hostile camp, and the tribesmen drew off, and the action terminated indecisively. The weather was miserably wet and cold. The train was stuck in the mud nine miles away, and the troops spent the night in the rain, devoid of supplies, shelter, or blankets.

Next morning the column marched back to Shola, most of the wounded carried by hand, and the troops dragging their first-line transport, until they came up with the supply train about mid-day. Our casualties were 12 killed, 291 wounded; the enemy casualties were estimated at 200 killed, 500 wounded.

After this affair the Senussi became active in the oases bordering the Nile; and, lest they should invade the Nile valley, the 53rd Division and five brigades of Yeomanry (dismounted) were tied up in garrisons between the Fayum and Assuan. All the Senussi in these oases would have been cut off if we could have occupied Siwa; but, at this time, this was not considered possible.

Action at Agagir.—After the action at Hazalin, Major-General Peyton relieved General Wallace, and further steps were taken to oust the Senussi from the coastal plain in order to reoccupy Barrani and Sollum.

A depôt of supply was formed at Amgeila, about 50 miles west of Matruh; and, on 20th February, a column under Brig.-General Lukin was sent out from Matruh to attack the Senussi assembled near Barrani.

General Lukin's column consisted of:—

3 squadrons Dorset Yeomanry,
1 squadron Bucks Yeomanry,
1 battalion Royal Scots,
2 battalions South African Brigade,
1 battery Notts R.H.A.

After three days' marching, the column halted on 25th February in the Wadi Maktilla, and the enemy were located nine miles off, at Agagir, 14 miles south-east of Barrani.

They were about 1,500 strong, with three guns and five machine-guns. At 0600 hours on 26th February, General Lukin moved on; the Senussi stood until the infantry attack came on—when they broke, and their position was captured by 1400 hours. The pursuit was taken up by the Dorset Yeomanry, who charged the retreating column, with the result that the enemy lost heavily, were completely scattered, and Jafar Pasha was captured. Barrani was reoccupied next day. After replenishing, the column moved on, and retook Sollum on 14th March. Here, the armoured cars cut off all the enemy's artillery and transport. On 17th March, an armoured car detachment, under the Duke of Westminster, set out to try and find the camp in which the crew of H.M.S. *Tara* had been imprisoned.

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After travelling over 116 miles of unknown wastes, they hit on the camp and brought back some 40 survivors of the crew. The cars covered 240 miles of desert in 24 hours.

CHAPTER IV.

THE SECOND TURKISH ATTACK ON EGYPT—THE BATTLE OF ROMANI. THE BRITISH ADVANCE TO EL ARISH.

THE SECOND TURKISH ATTACK ON EGYPT—BATTLE OF ROMANI—BRITISH ADVANCE TO EL ARISH.—Difficulties of the *Entente* Powers at the End of 1915—Lord Kitchener's visit to Egypt—Evacuation of the Dardanelles—Complex Command in Egypt early in 1916—Formation of the Egyptian Expeditionary Force—Postponement of the Turkish Operations against Egypt—Revision of the scheme for defending the Suez Canal—Sir Archibald Murray's decision to occupy the Romani-Katia area—Release of 150,000 Troops from Egypt for other theatres—Turkish raids on Katia and Dueidar—Employment of mounted troops in the Sinai Desert—Advance of 18,000 Turkish troops into Sinai—The Battle of Romani, 3rd–4th August, 1916—Turkish plan of attack—The British counter-stroke—Difficulties of pursuit—Traffic over Sand; the palm leaf and the wire roads.

OTHER EVENTS IN THE EGYPTIAN THEATRE IN 1916.—Revolt of the Arabs of the Hedjaz—Defeat of the Sultan of Darfur—Occupation of Siwa Oasis—Advance of the E.E.F. to El Arish—Actions at Maghdaba and Rafa—Extension of the Military Railway—The Lines of Communication.

IN the latter half of 1915, things had not gone well for the *Entente* Powers. Germany had broken into Russia. The Austrians had overrun Serbia. Bulgaria had declared against us. Greece was looking askance at us. The Salonika expedition was having a very anxious time. Mesopotamia was our bright spot. At the end of October, General Nixon was authorized to move on Bagdad, and General Townshend, with the remains of the 6th Division and a cavalry brigade, pushed up the Tigris to Ctesiphon, 11 miles from Bagdad. But the Turks, no longer so pressed in the Dardanelles, had sent down 30,000 men, and on 22nd November General Townshend was checked, obliged to retreat, and hemmed in at Kut.

Lord Kitchener had visited Egypt early in November, and after this, the scheme of defence on the Suez Canal was entirely recast. Instead of allowing the enemy to approach the canal itself, he was in the future to be engaged in the desert. The canal was to be immune from long-range artillery fire. A line of strong posts and almost continuous entrenchments was laid out eight to ten miles east, parallel to the canal. To execute this work, metalled roads, railways, and pipe-lines, had to be built out into the desert from eight to nine points on the canal; and an immense amount of material and labour was expended. (See *Plate* IV.).

In December, 1915, at Gallipoli, Suvla and Anzac were evacuated. Just then, an intended Turkish attack in force on Egypt was widely reported; in fact, so aggressively was it advertised that it seemed to be overdone, and the information spread to mislead us. However, the troops from Gallipoli were brought to Alexandria to re-equip, and, to cope with the Turks, fresh divisions streamed out to

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Egypt from home. In February, 1916, we had some 13 infantry and mounted divisions there, nearly 400,000 men. Egypt, in fact, had become a rendezvous, and contained the general strategical reserve for the whole Empire.

Formation of the Egyptian Expeditionary Force.—The command and administration in Egypt at the end of 1915 was in a complex state. General Sir John Maxwell was in command of the "Force in Egypt." But, the War Office had a branch organization, mainly of Q.M.G. directorates, called the "Levant Base." This dealt with Salonika, Gallipoli, Mesopotamia, and India, independently of Sir J. Maxwell, and was controlled by General Altham. On the top of these two, there arrived the "Mediterranean Expeditionary Force" from Gallipoli, and the reinforcing divisions from the United Kingdom, with Sir Archibald Murray as Commander-in-Chief, and also independent of Sir John Maxwell. Thus, an extraordinary triangular situation existed. A dividing line about Zagazig separated the command of Sir Archibald Murray from that of the "Force in Egypt." G.H.Q., Mediterranean Expeditionary Force was at Ismailia; G.H.Q., Force in Egypt, at Cairo; H.Q., Levant Base, at Alexandria. Such complexity could not long continue. General Altham became the Inspector-General of Communications under Sir Archibald Murray. The Levant Base disappeared as an independent administration. Sir John Maxwell proceeded home; and, on 19th March, 1916, the Mediterranean Expeditionary Force and the Force in Egypt were amalgamated to constitute the Egyptian Expeditionary Force.

During December, 1915, and January, 1916, the concentration of troops in Syria was confirmed. Their numbers were estimated at 250,000, and the Turks were seriously at work developing the water supply in Sinai and extending the railway from Beersheba. The German Flying Corps with the Turks was increased, and our machines were outclassed all through 1916. In Mesopotamia, too, the Turks were very alert. General Townshend was shut in at Kut, the 3rd and 7th Indian Divisions from France, and the 13th Division (General Maude's) from Egypt, were diverted to the Tigris. Two attempts to relieve Kut, in January and March, failed.

The Western Desert Arabs, who had been driven off the northern coast of Egypt, but who were still assisted with arms and money conveyed by submarine through the Italian Tripoli coast, were still troublesome. And, in March and April, they invaded the oases of Farafra, Dakla and Khargha, and threatened the Nile valley. The Sultan of Darfur also was drawn in; Ali Dinar repudiated the suzerainty of Egypt, and raided into the Sudan province of Kordofan. In fact, in the spring of 1916, the Turk had made Egypt anxious for her frontiers on all sides.

But, the Grand Duke Nicholas' invasion of Armenia, and capture of Erzerum in February, and later of Trebizond, obliged the Turks

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to draw reinforcements largely from Syria; and their forces there became reduced from 250,000 to 60,000 in March, 1916, and their offensive towards Egypt was delayed.

Occupation of the Katia–Romani area.—Sir A. Murray had been directed to maintain as active a defence as possible, compatible with ensuring that no formed bodies of the enemy came within artillery range of the Suez Canal. And, as soon as he settled into his G.H.Q. at Ismailia, he reviewed the existing plan left by Lord Kitchener in November. The whole front was reconnoitred, and especially the area about Katia–Romani. It became clear that this water-bearing area offered far greater accommodation for large numbers of troops than had been previously realized. It was essential to any enemy advance in strength against Egypt. It afforded a place of assembly within two marches of the Suez Canal. Besides, it was established that Kossaima and El Arish wells were the two key points to the Sinai desert. It seemed preferable to guard the 45 miles between these points with mobile troops, rather than to anchor some 11 divisions in the Suez Canal fortifications, over 80 miles long. The desert may be a formidable obstacle, but it also affords a valuable screen for the enemy's moves.

Sir A. Murray decided as a first step to deny the Katia–Romani area to the enemy, and to occupy it at once. A force of a division of infantry, and another of mounted troops there, would enable the elaborate fortified belt in the desert to be abandoned, and the troops in Egypt to be reduced. As a first step, Yeomanry were moved out to the wells at Katia. Sir A. Murray proposed to reduce to seven the 13 divisions then in his command—six divisions were reembarked for France, Salonika, or Mesopotamia by the end of March, 1916.

At this time steps were taken to assemble three Australian and New Zealand mounted brigades into one formation—the Australian and New Zealand Mounted Division. This division concentrated at Salhia early in April, and four T.F. Horse Artillery batteries furnished its artillery.

On 11th April, a reconnaissance and raiding column set out from near Ismailia to Jifjaffa—52 miles. (One squadron, a light horse regiment, some Bikaneer Camel Corps, Engineers, a pack wireless set, and camel transport.) The enemy post at Jifjaffa was surrounded, 16 Turks were killed, the Austrian officer in charge and 33 others were captured, and the camp and water boring plant destroyed. Our losses were one man, one horse killed. The column covered 120 miles in three and a half days, and the utility of cavalry for desert work was fully established.

A railway was necessary for the supply of the divisions destined for the Romani area. The standard gauge was decided on, fortunately; for a narrow gauge would never have sufficed for the subsequent traffic. The local water was supplemented by a pipe-line for Nile

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water as the former had proved unsuitable for British troops. These works were commenced in April. This small beginning opened the offensive from Egypt. The initiative passed to us, which took us on, through Palestine and Syria, to the Taurus and Upper Euphrates.

The Turks now undertook one enterprise. On 24th April at 0500 hours, a flying column of 2,000 Turks, stiffened with Germans, successfully surprised our advanced posts at Oghratina and Katia. In all, three squadrons of Yeomanry were captured. A similar surprise by 1,000 Turks against Dueidar, held by a mixed detachment of Royal Fusiliers and Indian troops, totally failed. The enemy left 70 dead and 25 prisoners in our hands. We have it on German authority that the object of these big raids was to demonstrate to our leaders the danger to the Suez Canal, and to discourage the withdrawal of divisions from Egypt. But, Sir A. Murray had already sent away 150,000 men.

During the hot weather, from May to July, numerous long-distance reconnaissances and raids were undertaken by detachments of mounted troops, and much experience was gained. The conditions were arduous. The travelling was all over sand and rocks. The heat was often intense, especially during the periods of scorching Khamsin, or sandstorm. The only shelter were the scattered palm groves—called Hods. Water was the greatest difficulty. The Arab wells were always fouled, and unfit for our use, and often were too saline for horses. The horses had to be acclimatized to go unwatered for long periods; often 24 hours, occasionally as much as 60 hours. On the flat desert, horses got along well; but, in the big sand dunes, they sank up to the hocks. Generally, vehicles were given up and camel transport used. Guns were moved by means of pedrails—a device akin to the "Parsons' chain" for motor tyres—consisting of stout squares of planking, 2½ in. by 12 in. by 12 in., linked to each wheel by two circumferential chains. Teams were eight horses, one pair wheelers, three in the centre, and three leaders.

The second Turkish advance.—From June onwards, the Turks—no longer anxious about Bagdad—proceeded with their greater attack on the Suez Canal. Germany and Austria gave effective help, especially in aircraft and howitzers. The first step was to evict us out of the Katia–Romani ground. The expedition was led by Kress von Kressenstein, the Bavarian colonel who had previously organized the 1915 attack.

The Turkish force consisted of the 3rd, and part of the 23rd Divisions (15 battalions), two batteries of mountain artillery, heavy artillery (which was late in arriving), Engineers, and two companies of Camel Corps..

In all, about 18,000 men set out from Shellal, near Beersheba, on the 9th July, and, marching rapidly 120 miles, were in Abd and Oghratina by the 19th July. Here they remained in the palm

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groves, moving little. It was obvious that either they were awaiting more echelons, or they intended to stay to block our further advance. As soon as the Turks appeared at Abd, they were kept under close observation by the 2nd Australian Light Horse Brigade, whose orders were to watch, harass and delay any advance; to cover the right or southern flank of the infantry back at Romani; and, when opportunity offered, to envelop the left flank of the Turks.

The 1st Australian Light Horse Brigade took turn at this task. Sir A. Murray at once prepared to take the offensive, so as to be ready by full moon on 13th August.

On 3rd August, the Turks occupied Katia and Rabah, and pushed back our screen of mounted troops. The 2nd Australian Light Horse with two regiments covered the three-mile front from Khatib Gannit to Hod el Enna, leaving one regiment in reserve at Romani.

Battle of Romani.—The troops in this left section of the Canal defences were commanded by Major-General H. A. Lawrence at Kantara. He had the 52nd and 42nd and Australian and New Zealand Mounted Divisions, and some Yeomanry (seven infantry brigades, six mounted brigades, nine batteries), altogether about 30,000 men. Three of the four brigades, with the 52nd Division in front, were entrenched on a seven-mile position, facing east, from Khatib Gannit to the sea at Mehemdia. Five battalions were in general reserve south of the railway, about Etmaler. The mounted troops formed a line along the sand dunes, facing south, parallel to the railway. The brigades of the 42nd Division were echelonned along the railway from Kantara to Pelusium. General Lawrence's intention was to await the Turkish attack, involve the enemy in the heavy sand, and counter-attack with the 42nd Division and dismounted troops.

Von Kressenstein's plan, broadly, was to hold us in front, and to drive in our right, and cut in on the railway between Kantara and Romani. At midnight, on 3rd–4th August, the Turks advanced, supported by artillery about Bir Abu Hamra. Our right extended south further than they knew; and their troops, intended to interpose behind our Romani force, lost touch with their main attack, and got involved in very heavy ground, as our commanders expected. The Turkish frontal attack gained some ground at first, but the British counter-attack from the direction of Mt. Royston, Dueidar and Pelusium was successful. The enemy fell back in disorder, especially his left. The mounted troops were sent in pursuit, but the difficulties of ground, weather (August) and water, were too great for them; and the infantry could not follow up effectually. The Turks, well covered by rearguards, rallied at El Abd, and turned on the pursuers and checked them. The enemy lost about 5,000 killed and wounded. The British took about 4,000 prisoners.

In comparison with February, 1915, this attack was a disaster for the Turks. Von Kressenstein had lost 50 per cent of his force

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and much material. The British kept the initiative, and Egypt was never threatened again.

In this advance, the Turks brought up their heavy guns by spreading palm branches and mats on the sand. At the same time the British began to develop the "wire road," made of two layers of rabbit netting, 12 to 16 ft. wide, tightly pegged out at the sides. Infantry, cycles, and Ford cars travelled easily over sand covered with this wire; but mounted troops, or ordinary touring cars destroyed it. Hundreds of miles of such road were put down during 1917 and 1918.

Other events in the Egyptian Theatre during 1916.—In June, 1916, the Sherif of Mecca, long restive under the rule of the Turks, led the Arabs of the Hedjaz in revolt. Jeddah was taken on 12th June, Mecca soon after, and Taif surrendered on 23rd September. Only Medina resisted, and was blockaded by the Arabs.

In the Sudan, Sir R. Wingate sent a force under Colonel Kelly to settle with Ali Dinar, Sultan of Darfur. The Egyptian Army troops defeated the Sultan's army, about 5,000 strong, outside El Fasher on 23rd May. Ali Dinar escaped with 2,000 men, but was followed up and killed on 5th November. In the western desert the Western Frontier Force penetrated to the Baharia oasis on 19th October, and then occupied in turn all the western oases and eradicated the pro-Turk element. The chief Senussi leader fled to Siwa just before our troops entered Baharia.

The oasis of Siwa was the key to all the western desert oases, and hitherto it had been considered inaccessible to attack in force. Siwa lies 200 miles from the coast over a hard but waterless desert. The experience gained in the previous two years with Rolls Royce and Ford cars had proved that such deserts could now be negotiated with suitable mechanical transport. A column under General Hodgson was formed and equipped with armoured cars, Ford vans, and light lorries. These crossed the 200 miles of desert in a few hours, drove the Senussi out of Siwa, and occupied that oasis on 5th February, 1917. This finally settled the Western Desert trouble.

After the Battle of Romani, Sir A. Murray decided to clear the Sinai Peninsula of Turks and to reoccupy El Arish. All the troops on the east of the Suez Canal were placed under Sir Charles Dobell, and constituted the Eastern Force. The 42nd, 52nd and Australian and New Zealand Mounted Divisions under Sir Philip Chetwode were formed into the Desert Column to advance on El Arish. This advance was to be deliberate, accompanied by the standard-gauge railway, and a 6-in. pipe line from Kantara. Subsequently, a 12-in. pipe was ordered from America.

The railway advanced about 20 miles a month. El Abd, Salmana, and Mazar were occupied in turn; and just as the Desert Column was about to attack El Arish, the Turks evacuated it on 20th December and retreated up the Wadi el Arish. The British Forces

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occupied El Arish at once, and the Australian and New Zealand Mounted Division pursued and surrounded the Turks at Maghdaba on 23rd December, and captured the bulk of their troops.

The Turks also had garrisoned and entrenched the old frontier post at Rafa. This entrenchment was surprised by Sir P. Chetwode's Desert Column on 11th January, after a 29-mile night march. The garrison resisted stubbornly; reinforcements were hurrying down to them from Shellal, and our open flank was threatened. The New Zealand Mounted Rifles stormed the main redoubt, and then the rest of the Turks surrendered. The Desert Column took 1,000 prisoners, and withdrew to El Arish.

The Turks now abandoned the defensive position at Weli Sheikh Nuran in front of Shellal. The Desert Column remained about El Arish during January and February while the railway was being brought up. The advantage of sea power and communication was now reaped, for El Arish drew part of its supplies by sea, landed on the open beach.

Comments.—It is worth noticing that the operations in the North-Western, and Sinai Deserts were carried out under very differing conditions. In the former case, the troops were scratch formations, far from their base, ill-equipped, precariously supplied, and floundering in mud and water. They engaged the enemy and beat him, but were unable to pursue so as to reap the fruits of victory. In Sinai, at Romani, the troops were in proper formations, they had a railway; all the resources of Egypt were at their elbow; their physical difficulties were drought and sand. The mounted troops were able to pursue, and large captures were made, but the infantry were unable to back up their mounted troops, so that the pursuit was soon checked, and after four days of anxiety, the enemy was able to retire unmolested with most of his artillery. Later on, the advance became deliberate, depending for progress upon the railway construction, and the opportunity arose of the mass employment of mounted troops in cutting off retreating forces, as at Maghdaba, and in cutting out an isolated detachment, in the case of Rafa.

The Lines of Communication.—A detailed description of the remarkable services organized for the advance through Sinai, and into Palestine is beyond the scope of this narrative in outline. The following, however, contained features of peculiar interest a few of which can be touched upon.

The Military Railway was constructed, operated and maintained by Railway Companies, R.E. Much assistance was furnished by the Egyptian State Railways; rolling stock was lent, branch lines in Egypt were pulled up to provide rails, sleepers and bridges, and the workshops of Bulac did most of the heavy repairs for locomotives and vehicles. All the heavy labour was furnished by the Egyptian Labour Corps, whose railway companies (at one time 26,000 men) became skilled in bank work and track-laying. The line, of standard

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gauge, was carried along at a rate of about 20 miles a month—as much as two miles being sometimes completed in one day. From Kantara to the Wadi Ghuzzee the line was 140 miles long, and the branch line from Rafa to Shellal 17 miles. When Palestine was entered, the Turkish railway of 3 ft. 6 in. gauge had to be adapted for our use ; and ultimately it was converted to standard gauge (4 ft. 8½ in.). Light railways were built in front of Gaza, and later on used extensively in Palestine. These lines were of 2 ft. 6 in. and 60-cm. gauges.

The water supply of the troops depended upon the development of wells, and conveyance of the water by train, by camel convoy, and by pipe-line. Moreover, the water thus provided had often to be filtered and chlorinated. In the coastal area of Sinai, water is generally obtained by digging shallow wells in the sand close to the sea shore, or in the wadi beds. The supplies thus procured are scanty and saline. This water served for the animals, but it was unsuitable for constant use by troops ; and even the railway locomotives could not use it without loss of efficiency. At first, Nile water was brought out by train. Then pipe-lines—6 in., 8 in., and 12 in.—were laid and followed railhead from Romani to Deir-el-Belah. The water was distributed to the troops by camel convoy from railhead ; each camel carried two 12½-gallon tanks, known as *fanatis*. Much water development was done in the vicinity of the Wadi Ghuzzee. Large reservoirs were built at Deir-el-Belah, Tel-el-Jemmi, Abu Sitta, Khan Yunus, Shellal, and Rafa. A quarter of a million gallons of water daily were available for supply to the troops in October, 1917, and could be transferred by large pipe-lines to the distribution centres in need of it.

The Camel Transport Corps in 1917 amounted to 35,000 camels, organized in companies, each of about 2,000 camels. These companies were employed as first-line transport with Corps, or further in rear for convoy duty, bringing up supplies and stores from railhead to the fighting troops. The casualties in 1917 in camels were about 9 per cent. ; and again the camel showed his capacity for work under varying and adverse conditions, and his imperturbability under shell-fire. Donkey transport also proved very useful. Four companies, each of 2,000 donkeys, were formed, and the Egyptian donkey proved to be hardy and reliable on service.

The Egyptian Labour Corps provided over 55,000 labourers during 1917. The company organization was adopted, but the working unit was the " gang " of 50 men with headman ; 12 gangs formed one company and, as a rule, the men of a gang all belonged to one village. The work carried out was very varied in character. The E.L.C. made the roads, laid the pipe-lines, built the railway embankments, loaded the trams, manned the surf boats, stowed or discharged the cargoes of supply and store-ships, and were employed everywhere on conservancy duties. Every service and department gratefully made use of this valuable Corps.

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CHAPTER V.

PALESTINE: THE FIRST OFFENSIVE. THE FIRST AND SECOND BATTLES OF GAZA.

PALESTINE; THE FIRST OFFENSIVE. FIRST AND SECOND BATTLES OF GAZA.—Various events early in 1917—The Capture of Bagdad—Russian Revolution; Need for pressure on Turkey—The Sykes-Picot agreement with France—Natural Features of the South Palestine Frontier—The Wadi Ghuzzee—Beersheba and Gaza—First Battle of Gaza—Attractions of a *coup de main*—Plan for the envelopment of Gaza—Capture of Ali Muntar and Green Hill—Decision to withdraw the Mounted Troops—Relief of Gaza—Second Battle of Gaza—Increased strength of the position—General Plan, Two stages—The first successful, the second checked—Further attack postponed—Railway developments—Destruction of the Auja-Beersheba Line—Observations: Results of Sir A. Murray's offensive—Arrival of Sir Edmund Allenby.

Events in Mesopotamia, etc., early in 1917.—Simultaneously with Sir A. Murray's advance to the border of Palestine, General Maude, in Mesopotamia, had struck at the Turks at Kut on 13th December. The Turks there were kept very busy in January and February, 1917, so that their High Command were not disposed to reinforce their Palestine front. (See *Plate* V.).

On 24th February, the Turks were driven from Kut; and a fortnight later General Maude had evicted them from Bagdad; and the loss of Bagdad was an immense blow to Turkish pride, prestige and resources. In order to keep up the pressure on Turkey, and especially as Russia was in difficulty and faced with revolution, our higher command now decided on a further advance into Palestine; and Sir A. Murray was directed to press the Turks to the utmost—and directly.

The French took special interest in Palestine and Syria, and, as soon as it was decided to enter Palestine, it became necessary to arrive at a clear understanding with France, and delimit the extent of her territorial interests. Sir Mark Sykes, who had made a study of the political problems of Mesopotamia and Syria, and M. Picot, formerly French Consul at Beirut, were empowered to confer. The agreement which they arrived at has since been the subject of much controversy. Broadly, under this agreement, Great Britain got a free hand in Palestine, and a French contingent of all arms was to be attached to the Egyptian Expeditionary Force. The French territorial interests in Syria were recognized by us, but the agreement did not take into consideration—sufficiently to satisfy the Arabs—the possibility, which afterwards arose, of the formation of a separate Arab State centred in Damascus. The Arab movement at that time (May, 1917) was in a very nebulous condition.

Natural Features of the South Palestine Frontier.—Palestine is made up of a great mountain ridge running north and south, rising to 3,500 ft. On the east it falls very steeply to the trough of the Jordan and the Dead Sea. On the north and west the spurs run down gradually to the three great plains of Esdraelon, Sharon, and Philistia. The mountain ridge has been compared to the skeleton of a flat fish. All the spurs run out at right angles to the

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main ridge or back bone, and render very difficult the advance of a large force along it through Judea and Samaria. Only one road traverses this mountain ridge from north to south, passing through Nazareth, Afule, Nablus, Jerusalem, and Hebron, to Beersheba; and one road runs across it from west to east from Jaffa, through Jerusalem to Jericho.

The coastal plain of Philistia, on the south-west and south of the Judean Hills, is for the most part rolling downland. It has ample water for local needs from wells, and a regular rainfall from November to March. It is under crops from April to June. The inhabitants are partly Arabs with flocks, and partly village Fellahin.

There are many tracks over this area which, in dry weather, are passable for vehicles.

The principal roads over the Plain of Philistia are:—

(*a*) Jaffa–Ramleh to Gaza, keeping near the coast;

(*b*) Jerusalem to Gaza, *via* Latrun;

(*c*) Gaza to Beersheba.

All these roads were metalled in parts, but unfit to carry heavy traffic. The plain is about 15 to 20 miles across, but widens between Gaza and Beersheba to some 35 miles, and then merges into the Sinai Desert in a sandy scrub, with sparse cultivation when the soil admits.

The Judean Hills drain across the Plain of Philistia to the Mediterranean, and cut a series of deep *wadis* (dry in summer). The most important of these enters the sea six miles south of Gaza and, running north-west for the last 25 miles of its course, is known as the Wadi Ghuzzee. Its extensions penetrate far inland. The wadis Saba and Khalil run past Beersheba and skirt the Hebron road. Two other branches, the wadis Sheria and Khalassa, provide alignments for the railway to the north and the road to the south of Beersheba, respectively. The Wadi Ghuzzee resembles the Wadi el Arish in its spates; but they are more violent in character. The banks are usually precipitous, its bed is 100 to 300 yards wide and often stony. Water is obtainable in it by digging, especially near the coast, and there are perennial springs at intervals: Shellal, Tel el Jemmi, etc.

Beersheba and Gaza are the two historical gateways into Palestine. Gaza, in particular, has seen many armies pass over it, and has endured many sieges and sacks. The city of Gaza is built on a plateau about 200 ft. high, about two miles inland, and separated from the sea by a belt of sand hills. On the north-east and east are cultivated downlands, whose ridges at first tend to run parallel to the coast. The country becomes rocky and arid by Sheria as the foothills of the Judean range are approached. The Gaza plateau is irrigated on the south and south-west of the city, and the plots and paths are surrounded by dense cactus hedges. On the south-east and south-west are two prominent features, Ali Muntar and Samson Ridge, re-

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spectively. The former is a conical hill, dominating the surrounding plateau and the city. Samson Ridge marks the boundary between the sand dunes and the cultivation. To the south of Ali Muntar, over some 5,000 yards of open ground lie the Mansura Ridge, and Sheikh Abbas, whence the ground falls to the Wadi Ghuzzee, and it becomes much intersected and water-worn. At Sheikh Abbas, the ridge turns south-east and so the high ground forms a salient.

Across the Wadi Ghuzzee, the hills of Inseirat rise sharply to about 400 ft., and are scored with lesser watercourses, which afford good cover from view. All the ground, except in the sand hills by the coast, is easy to dig in and stands up well while dry. The country between Gaza and the Wadi Sheria offers little obstacle to mounted troops, but is almost devoid of water.

The First Battle of Gaza.—In the middle of January, 1917, the troops about El Arish comprised the Australian and New Zealand Mounted Division, and 42nd, 52nd, and 53rd Divisions. Besides, we were raising in Egypt the 74th Division and the Imperial Mounted Division. The 42nd Division was under orders to go to France, but was to be replaced by the 54th Division. The whole were known now as the "Eastern Force," under Lieut.-General Sir Charles Dobell.

The situation was remarkable. The Turks still held Auja and Kossaima, about 50 miles up the Wadi el Arish, with some 4,000 men by means of their light railway from Beersheba and Shellal, based on the Afule—Junction Station—Beersheba main line. They had only small detachments in Khan Yunus, Gaza, and Huj, and about Ascalon—where a landing was feared. The Desert Column had successfully mopped up their outpost at Rafa, and had fallen back to near the Wadi el Arish.

The positions of El Arish, Rafa and Gaza, relative to Kossaima, Auja and Beersheba are interesting. The distance from El Arish to Gaza is no more than from Kossaima to Beersheba; but, if the British could secure Gaza, they would have got behind the Turks' base at Beersheba, and the enemy would have to abandon South Palestine. Gaza was a tempting morsel, but it must be taken by a rush movement.

Just then, Sir Charles Dobell was unable to maintain his troops much beyond El Arish. The railway was not beyond the Wadi, and the available camel transport had only provided for the first line needs of the fighting troops in the heavy sand along the coast. No further move could be made until supply depôts had been built up, and train was improvised. But the aspect of the country was changing; the sand dunes were merging into gravel plains and sandy soil, passable for horsed vehicles and light motor transport. Water, too, was plentiful at Rafa and Khan Yunus, and in large pools on the Wadi Ghuzzee, and at Deir el Belah in a great lake.

The raid on Rafa alarmed the Turkish command. By the end of

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January the enemy cleared out of Auja, and put 5,000 men into Gaza. Besides, they had prepared an entrenched position on a regular glacis facing south-west in front of Shellal. But for all this, Gaza still offered an attractive objective for a *coup de main*.

Sir A. Murray decided to continue the advance by the coast, rather than by Beersheba. He had to cover the construction of the railway, and for this must occupy the line of the Wadi Ghuzzee. At the end of February, after the Desert Column had made a reconnaissance to the Wadi, the Turks abandoned the position they were preparing in front of Shellal; and it seemed likely they would also evacuate Gaza, as they had done at El Arish. The Commander-in-Chief determined, therefore, to advance rapidly on Gaza, as soon as the transport for the move could be ready, and when the railway reached Rafa in the middle of March. He would thus secure the Ghuzzee line, bring the Turks to battle, and, it was hoped, capture the garrison of Gaza. To increase the radius of action of the divisions, 15 improvised trains were assembled; a mixed assortment, consisting of:—

7 camel trains, first line transport (55 camels; 72 tons each train.)
6 divisional trains (72 limbered G.S. wagons; 72 tons.)
2 mixed horse and motor transport (70 tons each train.)

Secrecy and celerity were the essence of the intended operation. The aim was to capture and occupy Gaza before relief could arrive. The supply trains would admit of one day being devoted to the action, no more. If the coup did not come off, the troops must withdraw to be within reach of their food and ammunition. Once in Gaza there was plenty of water, and the force would draw supplies by sea.

The plan was to send the mounted troops across the Wadi Ghuzzee to the east and north-east of Gaza, to hold off reinforcements and to hem in the garrison. The 54th, 53rd and 52nd Divisions were to push into Gaza from the south and south-west, from Ali Muntar to Samson Ridge. A detachment advancing up the coast was to cover the left flank. (See *Plate* V.)

The divisions were unostentatiously assembled, between Sheik Zowaid and Rafa, by 24th March. Next day, they were concealed in the groves round Khan Yunus; and on the evening of 25th March, they were situated as follows:—

A. and N. Z. Mounted Division Imperial Mounted Division 53rd Division (attached)	The Desert Column, at Deir-el-Belah.
54th Division	About Inseirat.
52nd Division	Khan Yunus.

The main task in the infantry attack was given to the 53rd Division (158th, 159th, and 160th Brigades.)

The 54th Division was to be in support on the right; and the 52nd Division was kept in general reserve.

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The 53rd Division set out over the plain from Deir el Belah about 0100 hours; 158th Brigade leading, in line of battalions in column of route, and had reached El Breij at 0400 hours. A dense fog then came on. At 0435 hours the leading battalion groped its way over the Wadi Ghuzzee, and on towards its first objective, El Burjaliye, by compass bearing. By 0615 hours the 158th Brigade had concentrated near El Burjaliye, and it pushed on and occupied Mansura heights at 0745 hours. The fog lifted at 0820 hours, and then the Turks sounded the alarm. But the brigade kept moving, and by 0900 hours it was about 4,000 yards south of Ali Muntar, and, as yet, unopposed.

Meanwhile, the 160th Brigade had reached El Sheluf, the top of the rise to the Gaza plateau. The 159th Brigade, in reserve, was following up the 158th Brigade *via* Mansura. On the left, the 2/4th Royal West Kent Regiment had advanced over the Wadi Ghuzzee until held up by Turks, in the sandhills about Sheikh Hasan.

The mounted troops had done well. In spite of the fog, they effected their march, and reached their positions east and north-east of Gaza by 1000 hours. The Imperial Camel Corps were about Mendur. The Imperial Mounted Division faced east from Gaza. The Australian and New Zealand Mounted Division was at Beit Durdis, with patrols to Huj and Deir Seneid; and the 2nd A. L. H. Brigade was working to the coast through Jelabiyeh and isolating Gaza.

After a conference of brigadiers, orders for the 53rd Division's attack on Ali Muntar were issued at 1100 hours. The 158th Brigade moved from near Mansura at 1140 hours supported by the 159th Brigade. The 1/5th Royal Welsh Fusiliers were leading, in artillery formation (*i.e.*, lines of platoons, in fours, at 100 yards interval and 300 yards distance: "A" and "B" Cos. leading, "C" and "D" Cos. following.) The Turkish artillery opened fire when these troops were about 2,000 yards from the enemy on Green Hill, at about 12 noon; and the brigade got on to within 800 yards of the enemy, in full view, and was then checked. The 159th Brigade now came up on the right (less one battalion in Divisional Reserve).

At 1300 hours, to hasten matters, the A. and N. Z. troops had been ordered to close in on Gaza, and by about 1530 hours their pressure took effect. The 2nd Australian Light Horse Brigade from the north actually broke into Gaza; and the New Zealand Mounted Rifle Brigade penetrated into the suburbs from the east.

About Ali Muntar and Green Hill, the whole line moved on at 1345 hours and got to within 500 yards of the trenches, under very heavy fire. The 160th Brigade had now come up and were attacking on the left. At 1530 hours the 158th Brigade pierced the enemy defences by Ali Muntar Mosque, and took many prisoners; but at Green Hill the Turks held on stubbornly. About 1600 hours the

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161st Brigade of the 54th Division was brought across from Sheikh Abbas, and put in on the left of the 158th Brigade. It attacked Green Hill, well supported by the artillery, and carried its objective just as the sun set. Von Kressenstein at Huj was encouraging Gaza to hold out, and by 1700 hours his reinforcements were pressing the Imperial Mounted Division, until only a gap of four miles remained for the Australian and New Zealand Division to get back through.

At 1630 hours the situation was as follows: Gaza was enveloped, nearly all the Turkish trenches outside it had been taken. The 53rd Division held the Ali Muntar Ridge, but their right was covered only by a thin line of mounted troops.

The 54th Division's left was 2½ miles from the 53rd Division's right. The Australian and New Zealand Division—much extended—was engaged in street fighting, except one brigade which was holding off the Turkish reinforcements from the north. The Imperial Mounted Division was resisting the Turks from the north-east, and east, and south-east, and under artillery fire. Many horses had been 36 hours without water. It was, therefore, necessary to bring in the mounted divisions; and, it was then considered unsafe to leave the infantry on the captured ground with their flank exposed.

So, about 1830 hours, Sir C. Dobell ordered the 53rd and 54th Divisions to take up a line from Gaza on the left through Mansura and El Burjaliye, refusing our right. Thus we gave up the commanding position gained. Turkish reinforcements entered Gaza that night.

Next morning, although our advanced troops reoccupied Ali Muntar, the 53rd Division was unable to keep it against the violent Turkish counter-attack delivered at 0800 hours. The 54th Division also was attacked from Sheikh Abbas.

The time limit for the operation had arrived; the troops could not be maintained so close to Gaza; and during the night 27th–28th March the force fell back to Deir-el-Belah and Khan Yunus to replenish and refit.

Although the commanders did not know it at the time, victory had been in our grasp. The Turks in Gaza had lost heart, and the German Commandant had burnt his papers, bid farewell to his friends, and destroyed his wireless station.

The course of the action remarkably resembled that of the two preceding actions, Maghdaba and Rafa. In each case, the enemy was surprised, but resisted stubbornly until his reinforcements were at hand, and the breaking off of the action was under serious consideration. Only, in the case of Gaza, the risks of continuing the attack seemed to outweigh the offers of success. The two hours of daylight, lost in the morning by the fog, could never be made up, and Gaza was not taken until seven months later, under very altered conditions. Here certainly was a case in which fog had favoured the defence by its delaying power.

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The Second Battle of Gaza.—Immediate steps were taken to prepare to continue the attack on Gaza. The railway was extended to Deir el Belah by 5th April, and also supplies were landed there on the open beach from suitable vessels, with surf boats. Much was done in opening up roads and crossing places over the Wadi Ghuzzee, and in developing the water supply.

Lieut.-General Sir Charles Dobell was reinforced with the newly-raised 74th Division, formed from Yeomanry regiments dismounted; and the assistance of the Navy was secured for the next assault.

The difficulties Russia was now encountering also obliged us to maintain pressure on the Turks; and the second attempt on Gaza was accelerated for this cause; in fact, Sir A. Murray received orders on 30th March to advance on Jerusalem. The next attack was fixed for the 17th April.

The Turks were thoroughly roused and elated, and gave up all idea of evacuating territory. The garrison of the Gaza area was raised to 20,000 or 25,000 rifles (3rd Cavalry Division, 16th, 27th, 53rd and 54th Turkish Divisions, and much heavy artillery). The immediate defences were greatly strengthened and extended south-west, some 12,000 yards to Atawineh; and beyond that, a chain of strong works stretched to Hareira and Sheria, for about 16 miles towards Beersheba. About 8,500 rifles were kept in Gaza itself. No opening was left for mounted troops to pass through, and the watering difficulties prevented a wide envelopment. The enemy reserves were held on the north-east of Gaza, about Huj and on the Wadi el Hesi.

The plan now was to attack Gaza in two stages. The first step was to reoccupy the Sheikh Abbas–Mansura ridge, consolidate there and bring up the tanks and heavy artillery. The second move would be to subject the Turks to a severe bombardment, and then to deliver the assault.

The first stage opened at dawn on 17th April. By 0700 hours, the 54th and 52nd Divisions had crossed the Wadi and taken Sheikh Abbas and Mansura Ridges, and Kurd Hill. On the right, the mounted troops about Shellal reconnoitred in force towards Hareira and Sheria, in order to hold the enemy to his ground there. At dark, these troops fell back across the Wadi Ghuzzee, but covered the right flank of the 54th Division with an outpost line. So far, the operations had gone well.

The next stage was fixed for 19th April. The 54th and 52nd Divisions, under G.O.C., 52nd Division, were to take Ali Muntar, the 54th Division had also to deal with part of the Kh. Sihan group of works, south-east of Gaza. The 53rd Division had to move up the sand dunes between the Belah-Gaza road and the sea, its first objective being the line Samson Ridge–Sheikh Ajlun. The Mounted troops were to attack (dismounted) the trenches at Atawineh, and to seize the Birket el Sana spur across the Wadi Sheria.

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The mounted divisions moved at dawn. Birket el Sana was taken, and the Atawineh lines were attacked by the Imperial Mounted Division, but without material progress. On the right of the 54th Division, the Imperial Camel Corps ejected the Turks from one line of the Kh. Sihan trenches. The 54th Division made progress at first, but came under severe enfilade fire from Ali Muntar, and was heavily counter-attacked and checked. The 52nd Division got up to Lee's Hill, but could not cross the open space to the west and north-west in face of machine-guns. The tanks, from which much had been expected, were unlucky, and several sustained direct hits. But, the 53rd Division, moving along the coast, secured Samson Ridge by 1500 hours.

By that time, the situation was that the attack had been brought to a standstill. Two of the brigades of the 52nd Division, and all the 74th Division, had not been seriously engaged. But the enemy was unbroken; he was still in possession of the Ali Muntar works; and his strong reserves were seen to be still intact. Our casualties, so far, had amounted to about 7,000, and it was considered that the time had not come yet to put in the reserves. No further progress was made. The ground gained on this day was consolidated. The line now ran from the Wadi Ghuzzee round the Sheikh Abbas salient, Mansura–Samson Ridge–Sheikh Ajlun. The further assault intended for the next day was countermanded, as the conclusion reached was that the Turkish defences and forces were too strong to be overcome except by very deliberate process.

After the Second Battle of Gaza, Lieut.-General Sir P. Chetwode succeeded Sir Charles Dobell in command of the Eastern Force. Position warfare set in on the Gaza front from Tel el Jemmi to the sea. Inland from the Tel el Jemmi, the hostile lines diverged east and west from the Wadi Ghuzzee. The country was open, but movement was restricted by the summer water scarcity. Neither side could effectively attack the other across the open space.

The Turks were strongly reinforcing Gaza; they now proposed to hold us on the Palestine front, while they concentrated their Yilderim Army for the recapture of Bagdad. In order to maintain the Gaza fortress, they began in May a branch railway from Tine (near Junction Station) to Gaza.

At the same time, the British, working for power to manœuvre, and to secure the upper line of the Wadi Ghuzzee, commenced a branch railway from Rafa to Shellal—where there was ample water—and also extended the pipe-line on to the plateau overlooking Shellal from the west.

Moreover, as it was evident that large reinforcements, especially in artillery, would be required for the reduction of Gaza, the double tracking of the railway from Kantara was decided on and commenced; and the 12-in. pipe was also to be duplicated between Rafa and Kantara.

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Destruction of the Auja–Beersheba Railway.—The Turks had abandoned their Sinai railway extension at the end of January; but in May they began to pick up the rails and sleepers in order to use them on their new branch line from Tine to Gaza. Sir Philip Chetwode decided to stop this work, and to do so organized a large destructive raid by mounted troops. The Imperial Camel Corps at Rafa, one brigade of the Australian and New Zealand Mounted Division, two field squadrons, and R.H.A. were detailed for the operation. A large number of demolition parties were specially trained and drilled to rapid work. In order to confuse the enemy, the Gaza defences were subjected to severe bombardment and wire-cutting for three days prior to the enterprise; and on the day of the raid, the remainder of the mounted troops made a reconnaissance in force to the north-west of Beersheba, and destroyed the Irgeig railway viaduct by shell-fire.

The raiding brigades moved out on 22nd May, the Imperial Camel Corps from Rafa direct to Auja. The others moved from near Khan Yunus to Esani and Khalasa, where they watered, and thence went on to Asluj and Hadaj on the railway. They completely wrecked 13 miles of line. Every pair of rails was cut in the centre, all the points and crossings at Asluj Station, six bridges, and many valuable stores were destroyed. The troops then withdrew unhindered.

Comments.—The outstanding feature of the recovery of Sinai was the energetic offensive initiated by Sir A. Murray. As a result of his enterprise the Turk was wholly driven out of Egypt, east, west, and south, and his machinations for revolt brought to nought. Besides, with material British support, the Arabs had destroyed Turkish authority in the Hedjaz. After the defeat at Romani, the Turk had displayed no initiative whatever against us.

The success of this offensive—for success it was, notwithstanding the check at Gaza—may be attributed to the *mobility* given to the whole force, and to the development and able use of the mounted divisions—Yeomanry, Australian and New Zealand troops. The mounted arm was constantly employed, in spite of the difficulties of desert, sand, season and water. It was used in reconnaissances, in raids, as a screen, as a mobile reserve, in envelopment, and in pursuit. The Sinai Desert was the training-ground in which these mounted troops were schooled for their later exploits in Palestine and Syria.

The spring of 1917 had certainly been disappointing for the British, but the Turk had cold comfort, too. His prestige in the East was very low; he had been turned out of Sinai, and defeated in the west; two of the holy cities—Bagdad and Mecca, were lost, and he was blockaded in Medina. Nevertheless, he was gathering himself together for a great effort to recover Mesopotamia with German aid.

Just at this time General Sir Edmund Allenby, who had been in command of the 3rd Army of the B.E.F. in France, came out to succeed General Sir Archibald Murray, at the end of June.

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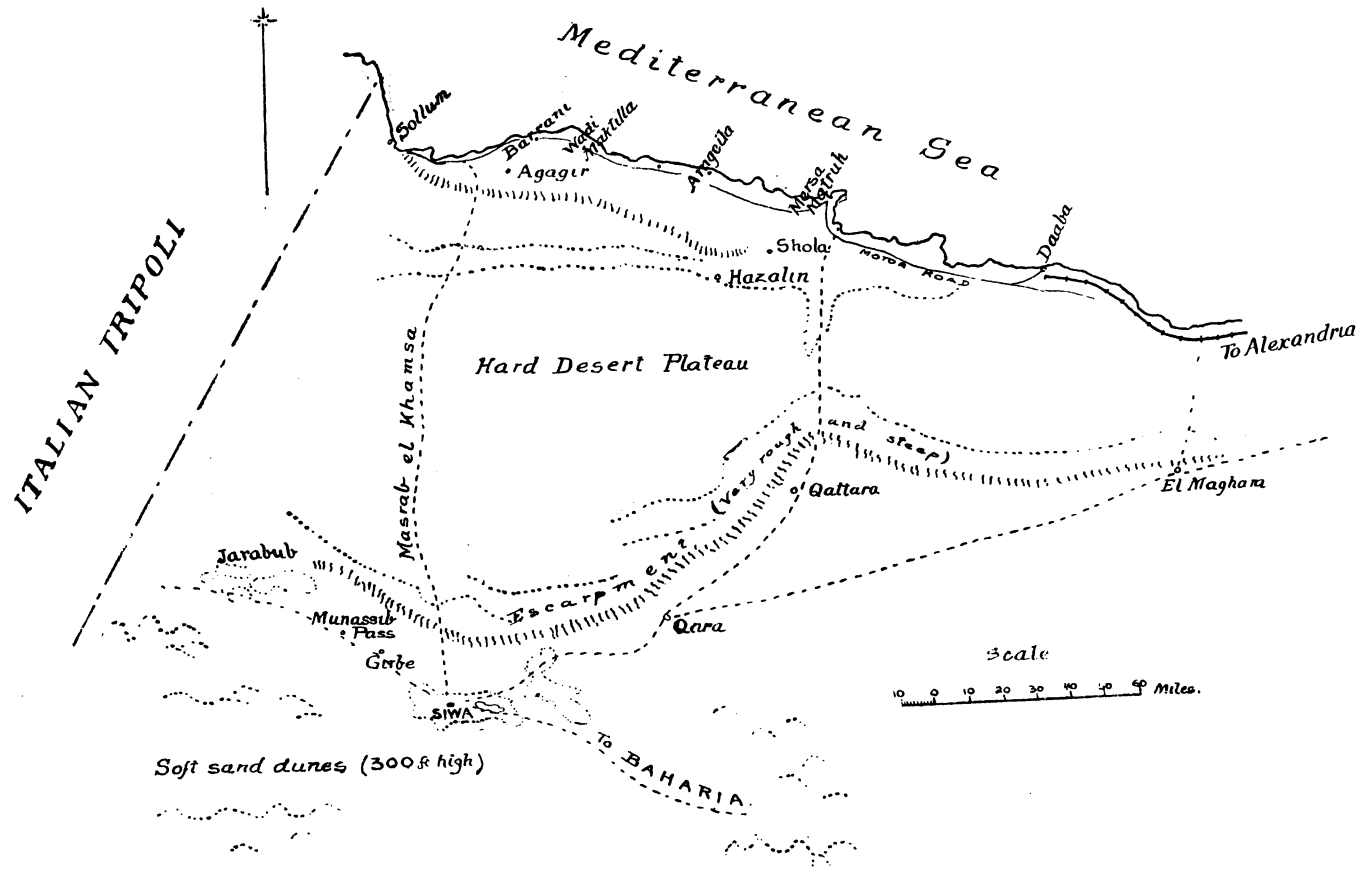
OPERATIONS AGAINST SENUSSI, 1915-1917.



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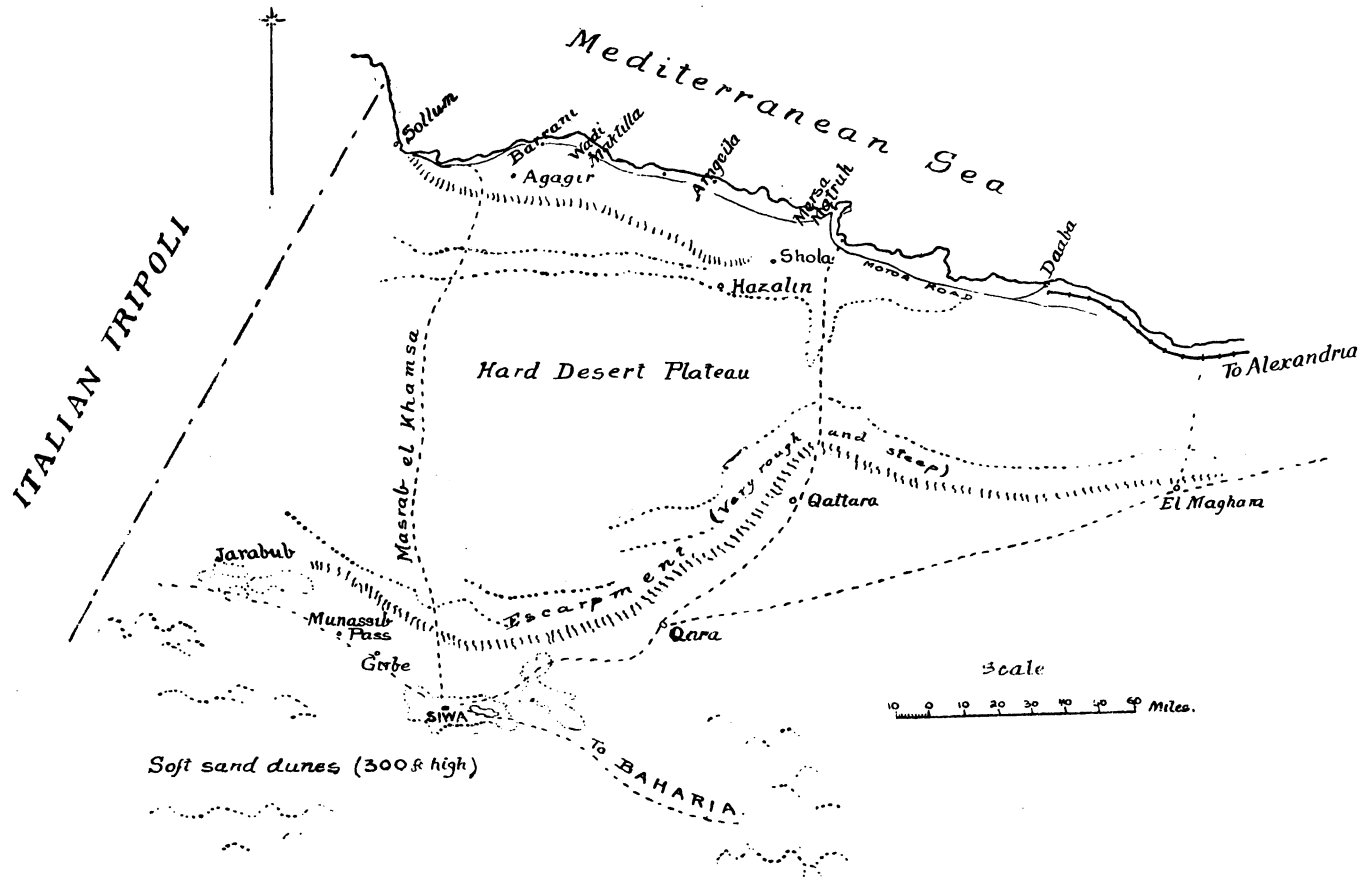

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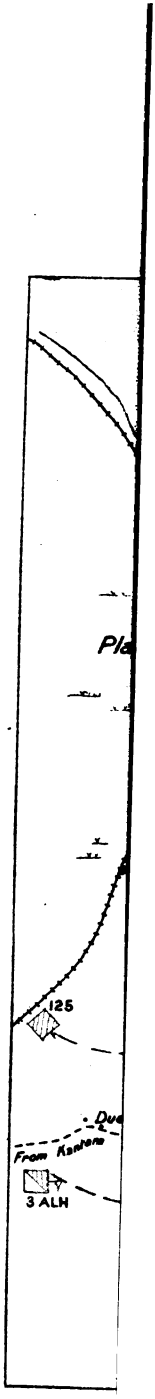

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NOTES ON REFRIGERATION.

By CAPTAIN J. H. DYER, M.C., R.E.

HAVING recently spent some weeks attached to a manufacturing company who have specialized in refrigerating machinery since its earliest commercial application, the writer is taking the opportunity of recording some of his impressions, especially in amplification of the article, *Notes on Refrigeration*, published in the *R.E. Journal* for November, 1921.

The statement that ammonia compressors are usually of the double-acting horizontal type, running at 70 to 90 r.p.m. is accurate only so far as it applies to the larger sizes. The manufacturers referred to have been building a regular line of machines up to eight tons ice-making per day, at speeds up to 200 r.p.m. for the last 15 years. The system is now being applied to larger machines, and machines of 75 tons daily ice capacity, to run at 250 r.p.m., are being made. The only real advantage of increased speed seems to be the possibility of direct coupling to motive power, oil, or gas engine or electric motor. It seems doubtful whether the compressor will be much cheaper, even if smaller, owing to its higher speed; but space occupied will be less, belt losses eliminated, and cost of foundations greatly reduced.

The statement that air will be drawn into the plant if the care of the rod is neglected is, of course, true, but necessarily only applies where the gauge suction pressure is something less than 0 lbs. per square inch (for NH_3 this corresponds to *minus* 28·5°F.), which it seldom is (*i.e.*, suction pressure is generally higher than atmospheric).

On the subject of "clearance," it should be noted that the oil-injection machines have not been manufactured for over 12 years, though many are still at work. The system is really a survival from a time when conditions were different to those existing now—ammonia very expensive, and good packing difficult to obtain.

In the observations as to running conditions, enough stress does not seem to be laid upon the absolute necessity of not running the compressor too cold, *i.e.*, with the returning gas too wet. If the gas is too wet, then, however small the clearance, re-expansion will occur, and a consequent great drop in the work done. It is suggested that rather more than hand-warm is the usual temperature of the discharge-pipe. Normally, it should feel really hot to the hand.

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ICE-MAKING.

The Can System.—The normal thickness of ice in larger plants in this country is 12 in. The statement that 11-in. ice freezes in 60 hours requires amplifying. The time of freezing depends on the temperature of the brine. 60 hours for 11-in. ice is correct for 18° F. brine. A usual workshop rule is that the time (T) varies as thickness² (C) ÷ 2, or $T_1 = \frac{C^2}{2}$ for brine at 18° F. For other temperatures, say 11° F, to find the time (T_2), $T_2 = \frac{32-18}{32-11} = \frac{2T_1}{3} = 40$ hours.

By increasing the size of the compressors, therefore, so as to work at a lower temperature, the size of the ice-tank and the number of cans can be reduced for a given daily output, but the power costs per ton of ice are increased.

The Cell System.—Owing to its first cost this is hardly ever installed now, but it should be noted that there is no reason why cell-ice should take longer to form than can-ice at similar temperatures, and, in fact, it does not; and the only possible reason for a smaller output per compressor unit is the extra reduction losses owing to brine piping, and the heat lost in cooling the unfrozen water.

Direct Expansion Systems are referred to, and it is suggested that the "Empire" System referred to is in an experimental stage, no commercial plant being in operation; the "Pluperfect" System also appears to be only slightly beyond the experimental stage, few plants having been in use for many years and these largely for the crushed-ice trade, which is by no means the whole.

The only advantage which the direct freezing of ice, compared to the use of brine can possibly have is if the same or a higher evaporating temperature is used, thus obtaining a greater or the same temperature difference between the refrigerant and the water, with the same or more efficient temperature conditions for the compressor.

Theoretically this condition should always be obtainable, but practically, owing to the higher first cost of direct expansion plants as compared to Can plants of a similar tank capacity, there is a tendency to reduce the tank capacity of the direct-expansion plants and work with even a lower evaporating temperature than with brine plants. The practical effect of this is that a study of actual conditions almost always reveals a less efficient temperature condition with a direct expansion plant.

The peculiar form, also, of Pluperfect ice, producing, as it does, a block weighing perhaps 7 cwt., with rounded ends and central holes, makes it most difficult to handle and store, as it cannot be admitted that "in most cases ice is crushed before use."

The figures of ice produced per ton of coal, it is suggested, are

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unintentionally misleading. The efficiency, on the lines given, is only important in so far as it is a function of the tons of ice per ton of coal.

A Pluperfect plant, equipped with an equally bad power-unit, as the Cell plant quoted, would give exactly similar unsatisfactory results.

The typical temperatures given suggest winter weather. It is seldom an ice manufacturer is lucky enough to have a condenser-pressure of only 107 lbs. The brine temperature also will usually be found to be much nearer 15°F. for both can and cell ice.

Selection of Plant.

(1) *Unit of Output:* 1 ton of Refrigeration=B.T.U. absorbed by 2,000 lbs. of ice at 32° F. melting to water at 32° F.=288,000 B.T.U.

(2) *Output Required:* (*a*) *Ice Making:* Allow 2 tons of refrigeration in 24 hours per ton of ice-making capacity in 24 hours required. [N.B.—Machines are rated to give so many "tons of refrigeration" in 24 hours for a standard suction pressure (generally 27 lbs. gauge for ammonia). The output of the machine is greater for a higher suction pressure and *vice versa.*]

(*b*) *Cold Storage:* Allow 1 ton of refrigeration in 24 hours per ton of meat to be stored at 32° F. and add 25% for maintaining the store at the low temperature in addition to extracting the original heat from the meat.

(3) *Type of Machine:* (*a*) *Ammonia Compressor:* most efficient. Little trouble with joints, as pressures are moderate and leaks easily detected.

(*b*) CO_2 *Compressor:* very compact and non-poisonous. Very inefficient in tropical climate where cooling water is above 80° F. Very high pressures.

(*c*) *Ammonia Absorption Plant:* only 35% of the efficiency of an NH_3 compressor. Only semi-skilled attention required. Use where a large quantity of low pressure steam is available.

(*d*) *Air-machines:* only 25% of the efficiency of an NH_3 compressor. Simple to use. For low temperatures snow collects in the air-ducts and requires frequent clearing. Use where only a moderate temperature is required in the store, *e.g.*, 50° F. for magazines in tropical countries.

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A METHOD OF MILITARY SKETCHING FROM THE AIR.

By BT.-LIEUT.-COLONEL H. ST. J. L. WINTERBOTHAM, C.M.G., D.S.O.

IN the *R.E. Journal* of February, 1921, and in the *Journal of United Service Institution of India* for April, 1921, Lieut.-Colonel G. A. Beazeley, D.S.O., R.E., of the Survey of India, describes a method of military sketching from the air in articles entitled, "Topographical Air Survey." So much experience has been gained in surveying from air-photographs, and so much discussion has centred on it, that the thought of a topographer actually seated in an aeroplane and working on a plane-table comes with something of a shock. It is undoubtedly a possible method of field sketching, however, and must be considered on its methods.

Lieut.-Colonel Beazeley tells us that this method was attempted in Mesopotamia in order to provide a skeleton upon which to piece together large numbers of air-photographs taken in strips over such enemy territory as lay beyond the reach of triangulation. In the body of his text this underlying purpose is somewhat obscured, however, and his article is really a description of the instruments and methods advocated for making a sketch map of a large area, at some such scale as 1/125,000. Very briefly he developed his work on the following lines. The topographer was equipped with a plane-table which was kept constantly oriented (by compass or sun azimuth). Position at any moment was obtained by drawing a ray forward from a known back point (along an alidade aligned and pivoted on that point) and by measuring along this ray the distance travelled since the aeroplane passed over it. The distance was measured from that one of a number of time scales which corresponded to the calculated ground-speed of the aeroplane. No interpolation was possible, because the human observer cannot consult three trig. points simultaneously, but a certain amount of cutting in and rough intersection seems to have been possible. The bulk of the work was, of course, sketching, and the author recommends, as a preliminary measure, the sketching in of a grid of traverses which can be roughly adjusted and used as a control for area sketching. Form lines of the roughest nature were added. As a result we get a rough small-scale sketch map which should give a good general idea of the drainage and communications and a vague indication as to heights.

The author claims an accuracy of distance measurement of about 1/20. The errors of bearing would, I think, be of a larger order. One might consider, then, that the end of a 20-mile strip of traverse sketch might be anywhere on a circle of a 1-mile radius. These

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errors would tend, under favourable flying conditions, to be of a systematic order, but it would be impossible to guarantee this. The result was, however, obtained very rapidly. The author claims, for example, to have sketched 500 square miles of difficult country in nine hours. But in order to obtain this result we must postulate two factors. We must have a really expert topographer, and complete local mastery of the air. No such survey would be possible if the aeroplane were compelled to dodge enemy aircraft or "archies."

However, it is not with a complete sketch that we are primarily concerned. The camera gives us a picture which is, occasionally, difficult to use, but which, even with our existing methods and appliances, supplies data out of all proportion more accurate than could be got by sketching at 60 miles an hour. The really important claim made for sketching is the orientation and fixing of photographs in their proper place. Now will this sketch control be wanted in future wars? It certainly will not be wanted where any fair topographical survey exists. We may say definitely that a sketch made in this fashion can never be expected to compete with ground survey. Generally speaking, then, it is very unlikely to be used in any European war, and the discussion can be narrowed to unsurveyed countries and, probably also, to small wars. In these cases a rough control pushed ahead of the triangulation will be of immense value. Is the method evolved in Mesopotamia the best way to secure it? I think that at this point we can eliminate another class of surveys, *i.e.*, those in which detail, natural or artificial, is sufficiently marked and close to allow of joining up air-photo traverses and thus securing a control. The arrangement of such air-photo traverses in rough triangles was a feature of the Palestine war surveys and recent experiments at Cambridge show how accurately and consistently such series of photographs can be taken. Naturally considerable differences of altitude introduce appreciable error, but these will not attain the order of 1/20 if reasonable overlaps are allowed for.

But we have still to consider the case of a desert area so deficient in detail as to afford no means of identifying the position of successive photographs. There are, however, photographic methods of fair precision which take into account differences of altitude and by which a subsidiary order of control may be established in such cases. No existing method of photographic survey can be relied upon to extend its own control far, but errors of a larger order than 1/200 can be avoided. In a very interesting French post-war survey in Morocco, described in *Cahiers du Service Géographique de l'Armée No.* 38," and briefly alluded to in the *R.E. Journal* for June, * 1921, the subsidiary orders of control points were secured by photographic intersection and interpolation. There is also the autocartograph of

* "The development and present possibilities of Air-photography for Mapping."

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Professor Hugershoff, described by Major M. N. MacLeod, D.S.O., M.C., in the April, 1922, *Journal* of the Royal Geographical Society, and there are other methods at present in the experimental stage for attaining the same object.

We have at present little national experience in the use of obliques, but we know that, given well-trained pilots, we can maintain the camera within about 3° of the vertical, even without special apparatus, and therefore can photograph within the same limits at any desired inclination. Experiments now in progress may substantially reduce this error, and it seems certain that by photographing from above different known points or by interpolating from them we can plot points over a gap limited only by visibility. It is, in fact, only where a gap exists of, say, some 30 or 40 miles that one can see difficulty in pushing forward a photographic survey of a greater accuracy and in far greater detail than could be secured by sketching, and at such distances from known points it is probable that the observer would be as much at fault as the camera.

It may be maintained that no purely photographic method could be made so rapid as actual field sketching. No doubt, this is true. As the speed of the aeroplane is dictated by factors independent of either sketching or photography, it is probable that it will take as long to photograph as to sketch, and the time spent in developing printing and plotting will be additional. Our experience during the last war pointed to the need of a map at a scale at least as large as 1/40,000, and our ideas as to plotting and compiling are based on that fact. To compile from air-photographs a rough, but fairly accurate sketch map at the ½-in. scale would be nothing like so lengthy a process and would keep pace readily enough with any military requirements.

Even then, if photographic methods of pushing forward a control are still experimental, it is obvious that they will develop to much greater possibilities than can sketching and we should be ill-advised to waste time in pursuing the latter.

Military surveyors, and particularly those whose experience lay solely in the western theatres, will none the less find many ideas of value for the future in these article.

It is obviously sound for the map-maker to fly over the country he is to map, and Lieut.-Colonel Beazely's methods of locating position might be a most useful accessory on such a trip. His sun azimuth arrangement of a pin as vane, on a sun-dial drawn upon the plane-table to correspond with local mean time (or whatever time is actually in use) is simple and should be efficient. The "time" scale depending upon measurement of ground-speed carried out in both directions over a known base does not sound particularly satisfactory, but it is difficult to see how its use can be avoided, and lastly, the difficulties he met with and his methods of overcoming them are interesting and instructive.

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REVIEWS.

LES CHEMINS DE FER FRANÇAIS ET LA GUERRE.

Colonel Le Hénaff et Capitaine Henri Bornecque. Préface du Général Gassouin. Paris. Librairie Chapelot, 1922. (At present rate of exchange, about 9s.)

THERE are probably less than a score of officers in the world who could write on the use of railways in war with the authority of Colonel Le Hénaff. Before the war, and for a short time at the beginning of it, he was Commissaire Militaire of the Est Railway of France, the staff officer responsible for the preparedness for war of the most important strategic railway in the country, and, on the outbreak of war, for the movements required for mobilization, for the concentration, and the subsequent maintenance and strategical moves by rail of the forces on the eastern frontier. Early in the war he became *Directeur des Chemins de Fer*, a post he retained until his health broke down. Thereafter, until the end of the war, his wide experience was made use of with the Inter-allied Transportation Council.

The book is the most valuable contribution to the literature on the use of railways in a European war which has yet appeared. The French system for the military use of railways has stood the test of war, and no great modifications in it are contemplated. The book, therefore, will well repay study by officers both of the Q.M.G.'s branch of the staff and of the technical railway service. The conditions of stabilized warfare and a very extensive and highly organized railway system are, of course, quite different to those to be met with in, say, Palestine, Mesopotamia or South Africa, but in war on a grand scale, in which railways play a great part, principles emerge which are really just as important, though less obvious, in a campaign conducted in a country where the railway facilities are strictly limited.

The great part played by the railways in Foch's strategic moves is shown clearly. Between the 18th of July and the end of August, 1918, over 80 Divisions were moved by rail. The summer campaign may be compared to a game of chess with the Allied and enemy G.H.Q.'s as players, Divisions the pawns, and the railways the hands that moved them. Such moves were mainly parallel to the front, and the urgent need of good lateral communications is obvious. The peace-time railways radiated from Paris like the spokes of a wheel, with the Ceinture railway round Paris as the hub; from the earliest days of the war the French were busy improving the cross-country lines north of Paris which connected the spokes. All the main routes by which the British and French forces were connected north of the Ceinture passed through Amiens, and when, in the spring of 1918, that great railway centre was threatened, a very extensive system of new main lines was constructed with remarkable rapidity north-west of Paris and the old lines to the south-west greatly improved. Not only by large works like these but by numerous other examples the book shows how much must be done to an existing railway laid out for civil traffic of particular kinds and quantities, and between particular points, before it can handle successfully the quite different traffic between other points which it is called upon to deal with in time of war.

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The authors are not always quite accurate in what they say about the British railway service, but on the whole give a very fair account of it. The train discipline of the *poilu* was often held up to officers of the British railway service as a model; there is a refreshing admission that the *permissionnaire* equally with the leaveman did not always appreciate the seats in the *wagons amenagés* of the leave trains. It is interesting, too, to learn that the French *Commissaire de Gare* was sometimes as unpopular as his British cousin, the R.T.O.

Valuable particulars are given, showing what can be expected from railways of various gauges and from roads, and from other particulars given useful deductions can be drawn as to the relative time and labour required to construct a road or a railway system to deal with the same tonnage. The reconstruction of communications across the devastated zone was necessarily so slow that if the Germans could have retired to the Rhine, leaving all communications behind them destroyed on the same scale as in that zone, it would have been impossible to resume active operations against the enemy on a large scale for many months.

The book deals with many points of great interest both from the staff and from a technical point of view. No one interested in the use of railways in war should overlook it.

A.M.H.

THE LEINSTER REGIMENTAL ANNUAL, 1921-22.

THE Institution has received a copy of the *Annual* of The Prince of Wales's Leinster Regiment (Royal Canadians) for 1921–22, edited by Lieut.-Colonel F. E. Whitton, C.M.G. While deploring the necessity which has arisen for disbanding this famous old regiment, one cannot but admire the fine, light-hearted spirit in which it is making its exit from the scene on which it has played so many parts. The *Annual* shows nothing in keeping with the mournful interest which must be attached to its last appearance, and its contents fully justify its motto: "E'en in our ashes live their wonted fires."

F.E.G.S.

NOTICES OF MAGAZINES.

MILITÄR WOCHENBLATT.

No. 45.—Lieut.-General Balck contributes an article on the political position of Great Britain from the military point of view, in which he argues that our present position is more unfavourable than that obtaining after the Napoleonic wars. He declares that we are war-weary and on that account fail to stand up against French Policy. England, he says, has departed from her traditional policy in allowing the balance of power in Europe to be upset, whereby France has become possessed of the master voice in European affairs. Economically, too, England has lost ground, as the bulk of the European markets have become closed to her, owing to the depreciation in exchanges. Bolshevist Russia has openly declared its intention to destroy the British Empire by propaganda.

Referring to the results of the Conference in America on the subject

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of naval armaments, he goes on to give it as his opinion that our policy is influenced by a desire to debarrass ourselves of our Japanese Allies, whom England suspects of working to effect a junction with China.

The *Entente Cordiale*, he thinks, is dead, whence the change of front on the part of England towards Germany. The former German menace has become a French menace, enhanced by the Franco-Belgian Alliance. French policy in the Near East is hostile to England.

The position in India is causing grave anxiety. Anglo-Indian politics, he points out, have not succeeded in Afghanistan. The nationalist movement in Egypt has not yet subsided. The British Parliament has renounced its full sovereignty over Ireland. Particulars follow concerning the strength of the British Army.

No. 46.—Lieut.-General von Cramon gives some interesting particulars concerning the strategy of the Central Powers in 1916. This officer was the plenipotentiary representative of the German High Command in the Austrian Royal Headquarters. He was, in consequence, present at the various negotiations and deliberations which took place. He was, moreover, repeatedly employed by Field-Marshal von Conrad to represent his views. He therefore considers himself specially qualified to throw light on the much debated question as to why the Central Powers did not either undertake a combined offensive against Italy or alternatively throw their full weight against the Western Front.

He commences his argument with a short appreciation of the situation at the end of 1915, which he describes as a specially fortunate year after the defeats sustained towards the close of 1914. Russia was *hors de combat*, at any rate for a long time to come, Serbia had been overpowered, the road to Constantinople opened, Roumania had been intimidated, and the possibility offered to Austria to deal with Montenegro.

The situation, therefore, called for a decisive blow to put an end to the war, which had already lasted too long, and to give victory to Germany and her Allies.

Conrad had, during the summer of 1915, repeatedly confided to him his plan of a combined offensive against Italy, after whose subjection France should be similarly dealt with. His intention of breaking through from South Tyrol was in accordance with the plan of operations elaborated in peace-time. He was confident of carrying through an attack on the rear of the main Italian Army and forcing them to lay down their arms in the field, in which view General Krauss concurred. The results would, in their opinion, have had an influence not to be over-estimated in bringing the war to an end.

Falkenhayn was not so optimistic on this score, in which view von Cramon thinks he was probably right. He was, consequently, unable to take the responsibility of displacing nine German divisions from the Western Front, which would have greatly enhanced the difficulties of defence against the French and English.

Krauss and Conrad were of the definite opinion that in the event of the overthrow of Italy the Western Powers would be compelled to come to the aid of their Ally, whereby the Western Front would be materially relieved.

In support of this contention he cites the events of 1917. On the other hand, he points out the dangers to the right flank of the Germans

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on the Western Front. The difference of opinion of the two Staffs was further influenced by other considerations.

Conrad at first desired to conduct the attack on Italy with only Austro-Hungarian troops, and to reinforce them with divisions from the Eastern Front. These, he proposed, should be made free by German forces from the Western Front. It was only later that he asked for German troops for Italy. Falkenhayn could not be talked over to agree to either of these proposals, as he could not be convinced that the operation would materially conduce towards ending the war. Further, he would never agree to placing German troops under Austrian leadership, which Conrad assiduously maintained in Italy. Cramon declares that anyone having, as he had, personal knowledge of the difficulties which arose during the preparations for breaking through at Gorlice, and more especially later in the campaign against Serbia, on account of Falkenhayn's stipulations that the High Command must be German, must know that a combined offensive against Italy on the lines planned by Conrad was out of the question.

Why Falkenhayn did not accept the alleged proffered assistance of Austro-Hungarian troops in his attack on Verdun has not been satisfactorily explained to this day. Cramon tells us that Falkenhayn had always told him that this offer had now and then been casually mentioned in conversation, but had never been put forward seriously. Conrad asserts the contrary, and Cramon suggests that the solution of the riddle is probably that the offer was made only verbally. In point of fact, Conrad only agreed to giving Austrian support after the overthrow of Italy. He especially emphasizes this fact in his memorandum of 18. 5. 15 to Falkenhayn, wherein he states that Austro-Hungarian troops would not be available for participation in seeking a decision on the Western Front so long as Italy had not been placed *hors de combat.*

Cramon goes on to describe the incompatability of temperament of the two leaders, which was a stumbling-block to harmonious co-operation. His conclusion is that under any circumstances they should have agreed to a combined, as opposed to independent, action.

In his opinion the view accepted by many Germans that Austrian troops were not suitable for offensive action on the Western Front was true only in respect of certain formations. It was undoubtedly a great sin of omission on the part of the Germans not to have previously settled in peace-time the question of an uniform direction in war. That the views of the two Army leaders might differ could have been foreseen, and provision should have been made for a supreme authority —of German composition—able to issue orders without recourse to procrastinating negotiations. That this was not done affords, in Cramon's opinion, one of the many proofs that Germany was not responsible for the war.

H. DE C. TOOGOOD, *Captain, R.E.*

REVUE MILITAIRE GÉNÉRALE

April, 1922.

The Army We Require.—By General D'Urbal.—France may have to be ready for another war with Germany, in whose army certain Austrian

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units may be incorporated. Russia may side with Germany, but Poland should be able to contain her, and the *Little Entente* should be able to hold Hungary and keep the East in order. France cannot count on active assistance from Great Britain or Belgium, at any rate at first, and Italy has her eyes on the Adriatic and Aegean. This leaves the troops of France, and of her colonies, provided control of the sea is assured, alone to face Germany, and only the home and North African troops will be available at the outbreak of hostilities. Germany will have the advantage of numbers, but her mobilization must be comparatively slow. France should be able to forestall her on the right bank of the Rhine, with Berlin and Munich as ultimate objectives. The line of resistance of the 1st echelon or outpost troops of the invading army, from Holland to Switzerland, should be roughly—Ahaus, Dortmund, Hanau on the Maine, Stuttgart, Donaueschingen, approximately 30 miles to the east of the Rhine, with that river to fall back on in case of need. With fully-trained troops this line could be held by ten infantry and six cavalry divisions on each front north and south of the Maine, and the Germans should be unable to concentrate on a single front, but be obliged to concentrate behind the Weser and Danube with precarious communications between the two bodies along the comparatively narrow corridor between the French and Bohemia. The mobility and equipment of the French cavalry must be such that there would be no hesitation in sending it as far forward as Osnabrück, Minden, Cassel, Fulda, Bamberg and Nuremberg. The 1st echelon should number about 300,000 of all arms, and would be followed by a 2nd echelon provided with all requisites for open warfare, and a 3rd echelon comprising material for position warfare, second line, and line of communication troops. The total of the 1st and 2nd echelon should not be less than 800,000 for the north and 600,000 for the south groups of armies, and 200,000 should be added for *liaison* between the two. The first echelon should all be troops of the active army, stationed as near to the frontier as possible, and there should be a permanent nucleus ready to embody the 1,300,000 troops of the 2nd echelon, say one-fifth, or 260,000 and 50,000 more for the embodiment of the 3rd echelon. This necessitates a permanent army 610,000 strong.

The Revision of the Regulations.—(A continuation of the article by "Lucius," fifth period, continued).—*The Defence of Positions* (1) *From the German side (continued).*—By defending not the first-line, but the first position, the Germans hoped to maintain an economical defensive, but the Allied attacks on limited objectives, during which the barrages were too intense for the counter-attack troops to face, brought their tactics to nought, and, in 1917, their defences were captured step by step. The IVth Army Commander tried concentrating closer to his front the infantry necessary to defend the first line and first position, but the result was the same except that casualties were heavier. From the beginning of the battle of Flanders, Ludendorff held more strongly than ever his opinion that the remedy was to dispose both positions and troops in great depth, and published a new regulation on 15. 8. 17. This directed that the battle should not be in lines, but in zones, consecutive battle zones, each several kilometres deep and separated from each other by not less than three kilometres, with the double object of ensuring to

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the commander greater security in case his front was penetrated, and of forcing the adversary to prolong and repeat his preparations for attack. The first, or covering zone, was to be held by advanced posts to repel a surprise attack, give the alarm, and retard the enemy. The second, or principal zone of resistance should be able to stop even the most violent attacks and the main body, which was to hold it, would, by reason of its distance from the front, suffer less from the bombardment, and have plenty of time to occupy its defences. The third, or rear combat zone, would shelter reserves destined either to counter-attack in the second zone, or to stay the enemy should he have forced his way through the latter. Artillery would find its best protection in numerous alternative blinded emplacements, but, during the battle or for special missions, guns might have to fire in the open, and the same rules apply to *Minenwerfer*. The covering zone has the advantage of obliging the enemy to engage troops and appliances in considerable force which will then not be available for the main attack. As he progresses he will meet more numerous and unforeseen difficulties, and will have to elaborate several successive attacks to break through. These principles, first applied during the last days of the battle of Flanders, served as guides in the construction of the Siegfried, Brunhild, and Hunding positions.

The Defence of Positions (2). *From the French side.*—General Pétain collected all the ethics of the defence in two complementary Instructions —that of 20. 12. 17, on the defensive action of the larger formations, and that of 22. 8. 17, on the organization of the ground and employment of all arms. The former asserts the necessity for a strict combination of defensive with offensive action, the first to lead on to the second by its material and moral effect. The fundamental principle is organization in depth: successive positions, with the defending troops disposed in depth in each. There should be at least two positions separated by such a distance (six to eight kilometres) that both cannot be simultaneously bombarded by the same artillery preparation. Intermediate and switch positions may be prepared between each. A position comprises a number of centres of resistance formed by linking up supporting points, the elementary cell of the organization being the automatic gun detachment or *combat group*. "To make artillery fire and aerial reconnaissance ineffectual, it is indispensable to spread the essential elements of the defence over the ground, to separate them from the visible organizations and disguise them as far as possible. But this dispersion renders more necessary than ever a considered distribution of the means of defence, and a careful organization of command." While the artillery is distributed in depth, the infantry will be divided into guard troops to defend the covering position and principal parallel, garrisons for the supporting points and centres of resistance, support troops close in rear of the guard troops for immediate counter-attack, and a reserve further behind ready with artillery and tanks for a general counter-attack or counter-offensive. The defence must be active, not passive. The high command will fix the position of resistance, and here will be the principal parallel, defended by the guard troops, and the normal objectives of the counter-attacks of the supports or reserves. To avoid surprise, reconnaissance must be developed and the ground organized for manœuvre. Preparation for the active defence includes making

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plans: for defences, for reinforcement, transport and retreat. The action of the different arms, especially aviation and measures of defence against aircraft and tanks, must be carefully studied for the principal cases which may present themselves.

Almost at the same time as the Instruction on defensive action appeared *Directive No.* 4, dated 22. 12. 17, from the General-in-Chief. In case of an extensive enemy offensive (1) the first position must be so held as to shatter, or at least break up the first dash of the enemy, (2) only sufficient troops and material must be assigned to the front lines to ensure of good use being made of the organizations, and to guarantee the distribution of the main body in good time in the second and switch positions, the impregnability of which must be assured, (3) to employ the reserves not only in direct counter-attack, but in counter-offensives against the enemy's flanks or on an adjacent part of the front. The general reserves will be employed either in reinforcing the troops attacked, or in attacking in any direction judged favourable. This made the second position the principal position of resistance, which was also the tendency of the Instruction of 20. 12. 17. On the other hand, now appears for the first time the idea of replying to the attack not only by an active resistance but also by attacks in neighbouring sectors or in any favourable direction, a conception of manœuvre which will be the richer in results as capable of producing surprise.

On 24. 1. 18 the General-in-Chief issued his Instruction on the application of *Directive No.* 4, substituting for successive positions the *field of battle of the army.* The latter is "the whole organized region on which the army has to stand and beat the enemy. The essential element of this battlefield is the position of resistance, chosen in such a manner that the enemy can only attack it after a series of contests of which the effect will have been the separation of his infantry from his original artillery position." If it is lost in whole or part, the army commander must do his very utmost to recapture it. The ground between the position of resistance and the enemy consequently constitutes the margin of safety which the army commander disposes of to bring his forces to battle. It is, therefore, essentially a covering task which must be accomplished by the divisions which happen to be in contact when the enemy opens his attack, hence each of them must be disposed in depth so as to develop to the maximum the defensive capabilities of the ground and organizations, to put to profit the distance separating the enemy's front from the position of resistance, and to guarantee the time necessary to assemble the reinforcements (infantry and artillery) destined to stop the enemy on the position of resistance. Thus the evolution of the French doctrine of defence followed the same course as the German, but six months later. It is the same conception as that of security when at rest in active warfare.

VI. *Conclusion.*—To sum up, the second half of the year 1917 shows a growing use of material means, notably (*a*) artillery, a large portion of the heavy guns are now quick-firing, and at Malmaison there was one gun per six metres of front, which is not likely to be exceeded; (*b*) aviation, which is now not only an organ of observation and *liaison*, but contains chasing and bombing squadrons; (*c*) tanks, now used in masses and allowing of the omission of the artillery preparation, as at

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Cambrai, and making a tactical surprise almost certain; (*d*) the use of gas-shell for neutralizing the enemy's artillery personnel. This increased use of material means allowed of a diminution in the infantry engaged, and artillery tended to become the principal arm. Quick-firing heavy guns, tanks and gas-shell admitting of surprising the enemy, the efficiency of the defence appeared to be problematical and rupture of the front possible. The Germans were evidently very apprehensive on this point, and, in short, the conflict between arms and armour turned in favour of the former. But, in spite of this superiority on the side of the attacker, the result of the battle of the Aisne tended on the French side to a diminution of energy and lack of confidence in the success of large operations, and the tragic events of the spring of 1918 were to be required before courage was completely restored. The real reason why the Allied attacks in 1917 achieved only incomplete successes was that the material means were as a rule not quite sufficient, leading to failure at the critical moment to effect a practicable breach. Again, in 1917, Russia was not affording the assistance which was expected of her, and the Germans were able to transfer forces to France and relieve exhausted troops. It will be seen that the doubts of the Allies in regard to the possibilities of the attack were not shared by the Germans.

(*To be continued.*) A. R. REYNOLDS.

REVUE MILITAIRE SUISSE

No. 3.—*March*, 1922.

Search for a New Discipline.—The original article is the concluding part of one by Capt. Cingria begun in the number of the *Revue* for November, 1921 (see *R.E.J.*, April, 1922); in it an endeavour is made to meet some of the criticisms levelled against the views to which expression is given in the preceding parts of the original article. Capt. Cingria contends that the measures which he recommends will strengthen discipline and not destroy it, as some suggest would be the result if his views were carried into effect. He recognizes the force of the ethical doctrine which prompts a *free citizen* to render implicit obedience to a chief, and intends in no way to lend his support to those journalists, and others, who are for ever doing their best to lower the prestige of the officer class. Capt. Cingria is of opinion that the officer class must always constitute a distinct *caste*; indeed, that it should be regarded as a kind of aristocracy, consisting of men with a cultivation, which is higher, and an experience, which is wider, than are generally to be found in the men whom they are called upon to command. He does not believe in any greater democratization of the officer grades than exists at present. Again, he does not agree with those who think that discipline would be helped if officers lived the same lives as the rank and file, had their meals with their men and slept in the same dormitories. The adoption of such a course would, he feels, lead to the complete destruction of all real discipline. In a militia force particularly, it is, Capt. Cingria recognizes, essential that the officers should, when mobilized for training or service, be considered as being a class apart, but this does not, he argues, justify all the ceremonial with which the life of the officer is surrounded and which demands a sort of mechanical respect towards him from the rank and file. He is convinced in his own mind that

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discipline can be fostered in an Army on lines exactly similar to those by which it is maintained in the Boy Scout Organization. Capt. Cingria fully recognizes that a reform of discipline so as to make it accord with his idealistic views, presents a most difficult problem, involving as it does adjustments of the springs of anarchy, of bureaucracy and of dictatorship in such a way that their resultant effect will be to produce a perfectly stable state of equilibrium. The subject under discussion is of great public importance, and much of the matter contained in the original articles of this series is of considerable interest.

The Army and the Suppression of Civil Disorder.—In the original article, the author of which is anonymous, is described an incident which deals with the difficult problem of the employment of soldiers in aid of the civil authorities. A strike of the workmen in the dyeing industry took place in Basle on July 29th, 1919. A Strikers' Committee incited the malcontents to bring about a general strike two days later: the mischievous advice was acted on. The *Conseil d'Etat* of Basle took measures to meet the situation and, on July 31st, put itself in communication with the Federal Council. The latter body at once arranged for troops to be withdrawn from the frontier and, on August 1st, the 20th Company of Observation Troops was drafted into Basle; on arrival there it was quartered in the barracks, where its commander explained to his men their duties when acting in aid of the Civil Power and called attention to the rules laid down in the Official Regulations in relation to the use of arms on occasions of the kind then existing. Almost as soon as the troops reached Basle they had to be sent into the public squares for the purpose of maintaining order. The soldiers were attacked by the strikers and retaliated by firing on the mob. A workman in the crowd was hit by a bullet and died within a few minutes. The military authorities wished to convey the dead man's body to the Gynnastic Hall near the barracks, but were prevented from doing so by the strikers, who took charge of the corpse. The occasion was made one for a socialist demonstration: some 200 to 300 persons collected, and, having formed a funeral procession with red flags, etc., marched to the Gymnastic Hall. The entrance to this building from the public street being closed, the crowd attempted to force its way into the barrack square, the entrance to which was guarded by a couple of sentries, one of whom, on seeing the mob, which was approaching the gateway, had put the gates to and fastened them. The pressure of the crowd on the gates caused the fastenings to give way and the gates flew open. Thereupon a man rushed forward from the crowd and advanced to the gateway as if intending to force the sentries; at the same time he bared his breast and shouted defiantly to the sentries to fire. A couple of shots rang out: it is not known by whom they were fired. The main guard now fell in at the entrance to the barracks and opened fire on the crowd. Shortly afterwards the Company Commander arrived on the scene and stopped the firing. The funeral procession dispersed; however, during the fusillade a woman was shot dead. Why this latter victim was present in the tumult has not been explained. The mother of the dead woman brought an action against the Government claiming 11,700 francs as damages in respect of the loss of her daughter; the Federal Courts non-suited her

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on the ground that, according to the doctrine of the Swiss law, in such cases the responsibility for wrong-doing is placed directly on the tort-feasor, and then alone when the wrong-doing is an act in contravention of his duty. In this particular case it was shown that the troops had in no way violated the service instructions issued for the purpose of regulating their conduct in circumstances of the kind in which the unfortunate woman killed had met her death. In the original article the question is raised whether in certain circumstances there should not, on the grounds of justice and equity, be an obligation upon the State to pay compensation to third parties who suffer loss by an "Act of State." The author of the original article offers an answer to the question. He says that when the necessity arises for the State to defend itself or to take extraordinary steps to maintain public order within the realm, it becomes the duty of every loyal citizen to place his person and goods at the disposition of the community at large, and should one such in so acting suffer damage, he certainly makes a sacrifice, but in so doing he is but performing his duty to society.

NOTES AND NEWS.—*Switzerland.*—Attention is called to the paragraphs in the *Instructions du Service de l'Infanterie* for 1922, in which it is enjoined that the *pas cadencé*—the German Paradeschritt—shall form part of the drill training of recruits, N.C.O.'s and officers of the Swiss Army. This gymnastic step is to the Romand section of the Swiss Army like unto the proverbial red rag to a bull. The *Revue* takes the authorities to task for maintaining German traditions in the Swiss Army and points out that for the past fourteen years it has consistently objected to this essentially German parade trick: five grounds are given for the abolition of this particular kind of "goose-step."

France.—A Special Correspondent points out that the Provisional Instructions relating to the tactical handling of the larger formations approved by the French War Minister on October 6th, 1921, were published at the end of February, 1922. The volume opens with a declaration concerning poison-gas warfare, which it is thought will give rise to much criticism. The French military authorities, in effect, announce that if an enemy government, at the beginning of a future war, does not give a satisfactory undertaking not to bring into use those "weapons of war" which were proscribed at the Washington Conference, France will reserve to herself full liberty to take whatever action that the circumstances of the moment may then dictate. The general principles upon which the instructions have been built up are summarized in the original communication: the comments on them are too lengthy for reproduction here.

Attention is called to two volumes recently published in France: *Racolage et milice* (1701–1705) by G. Girard (published by Plon, Paris, 1922), and *Histoire militaire* by Lieut.-Colonel René Tournès (published by Charles Lavauzelle, Paris). The latter volume is recommended as a work which should be in the hands of all commanding officers, not only because therein it is shown how best they can utilize the men and materials placed at their command, but also by reason of the fact that the contents of the volume are of a nature tending to promote the general culture of the professional soldier.

W. A. J. O'MEARA.

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ACHIEVEMENTS AND LIMITATIONS OF WIRELESS TELEGRAPHY.

A lecture delivered at the S.M.E., Chatham, on 5th January, 1922, by L. B. TURNER, ESQ., M.A., M.I.E.E., *Fellow and Lecturer of King's College, Cambridge.*

1. INTRODUCTION.

WHEN I was honoured by the invitation to deliver a lecture on wireless telegraphy to the S.M.E., I accepted rather light-heartedly; for I felt that this was a subject on which there was plenty to say, and that suitable material could be selected and arranged without much difficulty. Later, however, when I had to abandon this comfortable vagueness and get on with the job, I found it very difficult to select my subject more definitely. The relation of wireless telegraphy to military operations seemed appropriate; but of the tactical aspect I am not qualified to speak, and the technical aspect presents problems of detail design, rather than of general interest. If I were to devote my brief hour or so to any reasonably limited technical topic, I should be unintelligible to all except wireless experts. I have, therefore, gone boldly to the other extreme, and propose to range sketchily over the whole field of wireless as it is and may be.

Wireless telegraphy, like (say) organic chemistry, is such a specialized subject, with a jargon of its own, that unless a man makes it his special study he is very apt to ignore it altogether. It seems likely, therefore, that many of those present have very vague notions, not only of the quantitative relations, the exact science of wireless, but even of the nature of the processes of the art. In this belief my object is to paint for you some picture of these processes, necessarily in the crudest colours; dwelling a little on the outstanding practical problems and difficulties, so that we may come to some appreciation of what are the limitations obtaining to-day, and how far they may or may not reasonably be expected to vanish after further experience, invention and research.

2.—THE THREE PROCESSES OF WIRELESS TELEGRAPHIC SIGNALLING.

The act of signalling without wires involves the setting up at will of a disturbance at the transmitting station, the propagation of the effects of this disturbance to the receiving station far away and not connected by wire, and the perception of these effects at the receiving station. That is, it involves the three processes of transmitting, propagating and receiving. We will take them in this order.

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3.—RADIATION.

It can be shown from familiar electrical principles that, whenever the current in an electric circuit changes, the consequent disturbance of the æther of space causes energy to leave the circuit, and an æther pulse travels away with the velocity of light. If the current is constantly changing, as in any ordinary alternating current circuit, power is constantly radiated from the circuit. In any such ordinary circuits, and at such ordinary rates of change, *e.g.*, 50 to 100 periods per second, the radiation, though necessarily present, is quite insensible in amount; but by merely modifying the form of the circuit and by increasing the frequency of the current in it, we can augment its radiating properties, and, in fact, arrive at the wireless telegraph transmitter. It is a difference of quantity only, not of quality.

The form the circuit assumes is that of the familiar aerial, a giant condenser whose one "plate" is a network of wires (an economical substitute for a sheet of metal) carried on masts high above the earth's surface, which constitutes the other "plate." Between the two plates is some form of generator (G, *Fig.* 1), pumping an alternating current of very high frequency into the condenser, the frequency being usually between (say) ten thousand periods per second, approached in long-range fixed-station work, and ten million periods per second, approached in highly portable military apparatus.

An accepted (though, perhaps, inaccurate) formula for the power radiated from such a transmitting aerial of height h kilometres is :—

$$1{\cdot}8 \times 10^{-8}\, h^2 n^2 \mathscr{I}^2 \text{ watts}$$

where $\mathscr{I}$ is the alternating current in amperes, of frequency n periods per second, pumped into the aerial by the generator G. This expression shows the importance of making the aerial high and the frequency large.

The wave motion set up in the surrounding æther by the alternating current in the aerial spreads out in all directions over the surface of the earth, with a speed of propagation approximately equal to that of light, *viz.*, 3×10^5 kilometres per second. Hence, if λ is the wave-length—the distance between neighbouring crests or troughs at any instant—we have the relation :—

$$\lambda n = 3 \times 10^5$$

allowing us to re-write the former expression in the form :—

$$1600\, \mathscr{I}^2 \left(\frac{h}{\lambda}\right)^2$$

This form shows us that for powerful radiation a large ratio $\frac{h}{\lambda}$ is wanted; or, for long waves, high aerials must be used.

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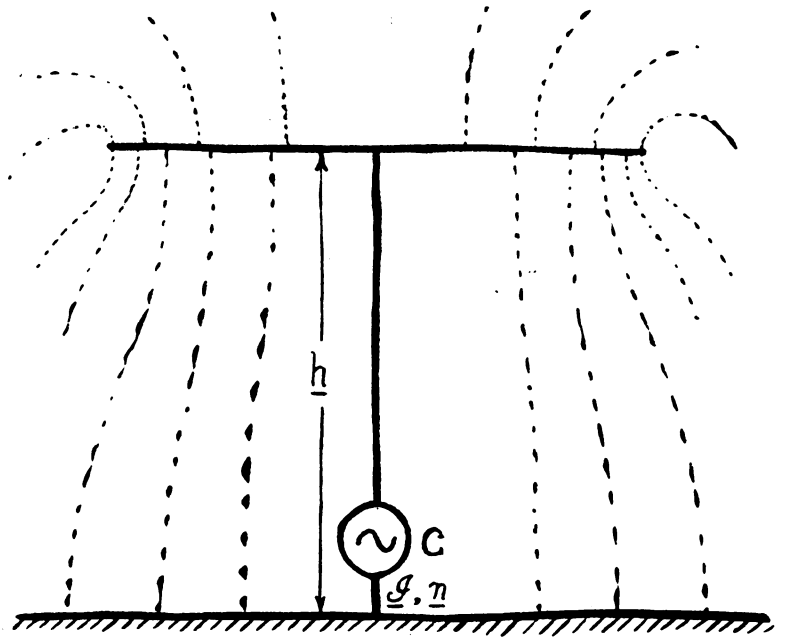

POWER RADIATED (WATTS)

$$= 1{\cdot}8 \times 10^{-8}\, h^2 n^2 \mathcal{G}^2 \quad \text{(km., p.p.s., amps.)}$$

$$= 1600\, \mathcal{G}^2 \left(\frac{h}{\lambda}\right)^2 \qquad \because \lambda n = 3 \times 10^5$$

FIG. 1.

4.—PROPAGATION.

Let us postpone description of the generator G, and pass on at once to consider the propagation of the radiated energy over the surface of the globe. If the Earth were flat and a good conductor, and if the atmosphere were a good insulator throughout, the intensity of the radiated power at increasing distances d would be inversely proportional to d^2. But modern science has taught us that the Earth is not flat, and that the atmosphere is even quite a good conductor up in the rarer altitudes. Consequently, the rate of falling off of intensity is, in the event, more rapid than the d^2 law, and is expressible by some such formula as :—

Intensity of radiation at distance d kilometres

$$\propto \frac{I}{d^2\, \epsilon^{\frac{\cdot 003\, d}{\sqrt{\lambda}}}}.$$

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If numerical values are attached to this formula, it will be found that at large distances d the rate of decrease becomes very rapid. Thus, for example, if the wave-length λ is four kilometres—a very ordinary wave-length, corresponding with a frequency of 75,000 periods per second—the following table shows the intensity at several distances between 10 and 10,000 kilometres, taking the intensity at 10 kilometres as unity.

Range d km.	Intensity of Radiation.
10	1
100	0·008,8
1,000	0·000,025
5,000	0·000,000,002,1
10,000	0·000,000,000,000,29

The table shows that in passing, say, from 1,000 to 10,000 kilometres, the power is reduced no less than about one hundred million times.

5.—Wave-Length Compromise.

A closer inspection of this exponential function shows that in order to minimize the rate of fall of intensity with distance it is necessary to use great wave-lengths for great ranges. There is, therefore, a practical conflict between short waves to give good radiation at the transmitter (with any feasible or economical height of masts), and long waves to give good propagation between transmitter and receiver. The compromise will obviously lead to the adoption of longer waves for greater ranges.

The high-frequency generators hitherto used, moreover, have been such as to require longer waves—or, rather, lower frequencies—with increased powers; and this has constituted an independent reason for the adoption of long waves for great ranges. For these, and perhaps other, reasons, the evolution of the wireless telegraphy of to-day has, as a matter of history, involved a striking procession from short to longer waves. Hertz produced waves of some two metres; in Marconi's early experiments the wave-length was of the order of 20 metres, which had grown to some 200 metres when the first practically useful wireless telegraphy had been achieved; by the early days of trans-Atlantic signalling the advance had been carried to 2,000 metres; and to-day the Bordeaux station is transmitting regularly at over 20,000 metres; from 1887 to 1922 an increase in wave-length of ten thousand times. Whereas Hertz's achievement was the production of waves of frequencies invisibly low—for with electric waves of visible frequency all creatures with eyes are familiar—difficulties are experienced to-day because the frequencies employed tend to be—indeed, are—no longer even inaudibly high.

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There is reason to suppose that this tendency to ever longer waves is receiving a check, and that the fashion will swing towards shorter waves. At the moment, the wave-lengths used for ranges of, say, 2,000 miles and upwards vary from about 6 kilometres (*e.g.*, at Clifden, Ireland) to 23 kilometres (Bordeaux) : the frequencies corresponding to these wave-lengths are 50,000 and 13,000 periods per second ; and the heights of the masts at the two stations named are about 200 ft. and 800 ft., respectively.

6.—High-Frequency Generators.

There are three chief methods of producing the high-frequency currents of powerful wireless telegraph transmitters. The first is that of the Poulsen arc, the principle of which is indicated in *Fig.* 2.

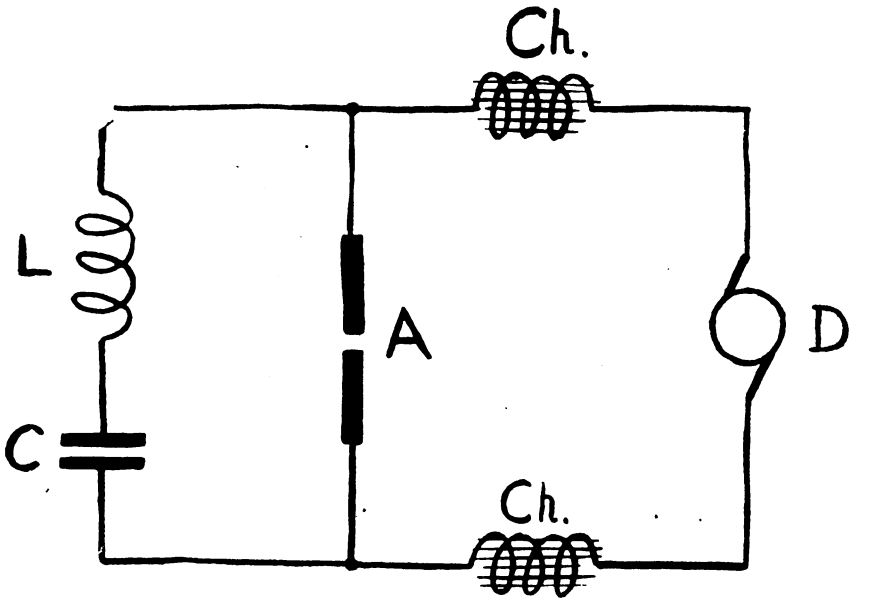

Fig. 2.

A is an arc, somewhat akin to an ordinary arc used for lighting purposes, fed with a current from the dynamo D, through the steadying chokes Ch. Across the arc is shunted an inductance L in series with a condenser C. With suitable relations between the electrical dimensions, an alternating current is set up and maintained in the circuit LCA. Its frequency is governed by the product of the sizes of L and C, and is approximately

$$n = \frac{1}{2\pi\sqrt{LC}}.$$

This alternating current is used for exciting the transmitting aerial.

This is the old singing arc phenomenon of Duddell, with modifications of the arc introduced by Poulsen to make it work at very

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high frequencies. These modifications include the provision of a hydrogenous atmosphere around the arc, and a powerful magnetic field across it. *Fig.* 3 is a photograph of an enormous arc of this character, that used at Bordeaux station, capable of dealing with an input of 1,000 kilowatts. The hydrogenous atmosphere is obtained by feeding into the arc chamber either hydrogen itself, or coal gas, or drops of methylated spirit and petrol. *Fig.* 4 is a view of the other side of a similar rather smaller arc.

The second method of generating the high-frequency current is that of the familiar electro-mechanical alternator. This method is not, strangely enough, merely the wild dream of an over-worked designer of 50-cycle machines, dementedly setting himself the nightmare task of multiplying his accustomed frequency a thousand times; it is the fine accomplishment of bold engineering design and construction, successfully and variously undertaken in America, in Germany, and in France. *Fig.* 5 is an example of such an alternator (the Alexanderson alternator at New Brunswick), a machine capable of an output of 200 kilowatts at a frequency of 22,000 periods per second.

Thirdly, there is the newest method of generating high-frequency currents, that of the thermionic triode oscillator—the "valve"—destined, in the opinion of some, to replace all other methods. I can only attempt to sketch the action of the triode in the very scantiest manner here; but I must not omit that, for the triode is a device which is already responsible for magnificent developments in wireless telegraphy and telephony, and in wire telephony, and is destined to render aid in a great variety of technical processes and scientific investigations,

Fig. 6 is a photograph of a transmitting triode. It consists of a vacuous glass bulb containing a central filament of tungsten (as in an ordinary electric lamp), surrounded by a cylindrical wire "grid," which is itself surrounded by an outer metal cylinder, the "anode." These parts are indicated diagrammatically in *Fig.* 7 as F, G, and A, respectively. When the filament is made white hot, electrons—*i.e.*, atoms of electricity, constituents of all forms of matter—escape from it into the vacuous space; the electricity may properly be said to be boiled out of the filament. Under the action of the battery, B, some of these electrons pass through the interstices of the grid, G, and reach the anode, A, so constituting a current of electricity traversing the vacuous space in the battery–anode–filament circuit. Now the magnitude of this current I is very much influenced by the potential V of the grid, as is shown by the curves in *Fig.* 7. The grid, therefore, acts as a sort of tap, which may be turned on and off extremely quickly, for the only moving parts in the whole system are the tiny electrons travelling across the vacuum with speeds approaching that of light.

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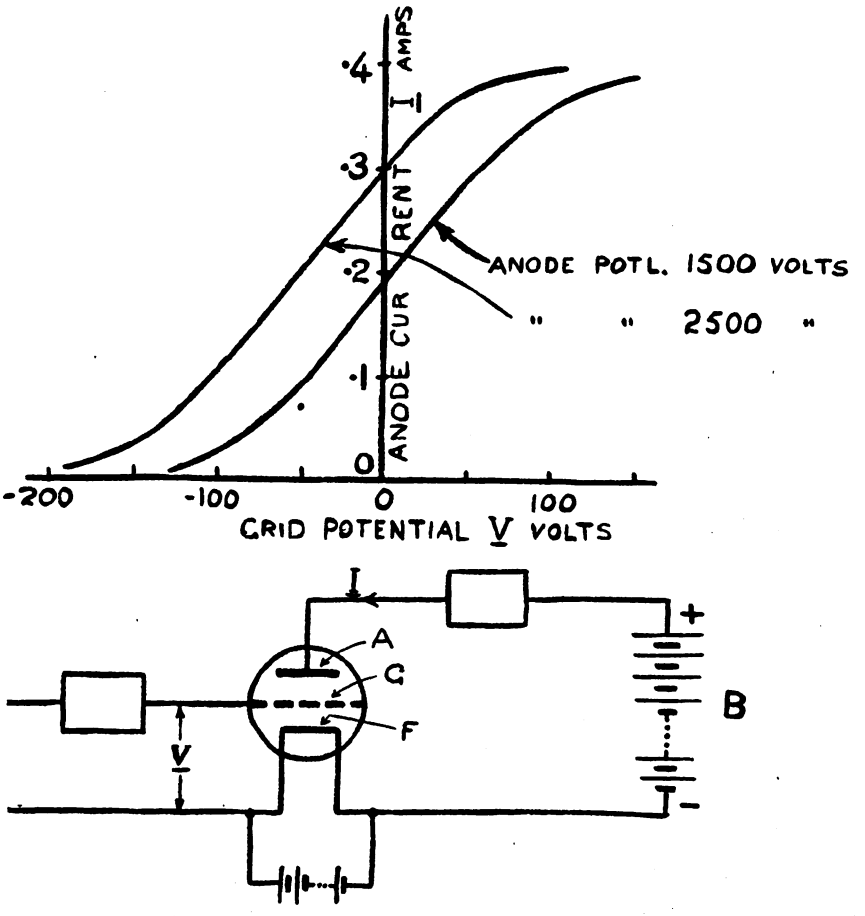

FIG. 7.

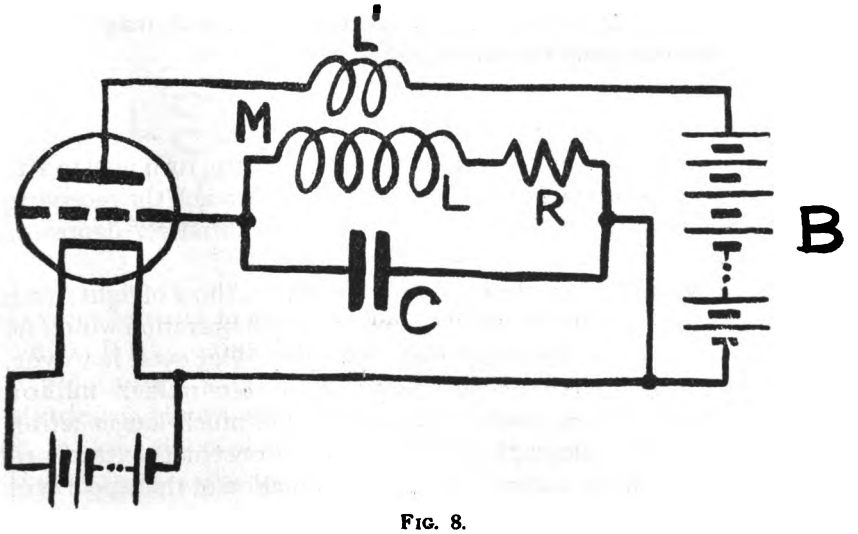

FIG. 8.

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This thermionic instrument will perform all sorts of services with astonishing elegance and ease, and one of these services is the generation of high-frequency currents with which we are at the moment concerned. A general idea of how this is achieved may be had by reference to *Fig.* 8, which shows one way of introducing the necessary retroaction or back-coupling between the grid and anode circuits.

Imagine that, by any means, the LCR circuit has been disturbed and so set oscillating with its natural frequency

$$n = \frac{1}{2\pi\sqrt{LC}}.$$

The fluctuation of grid potential thus caused produces a fluctuation of the anode current, and this current, flowing through Coil L^1 impresses an alternating E.M.F. in coil L owing to the mutual inductance M between the two coils. Under suitable conditions this E.M.F. suffices to introduce into the LCR circuit from the battery B enough (or more than enough) energy to make up for the loss taking place in the unavoidable resistance R. The grid and anode may be described as working upon each other according to a scheme of "tit-for-tat" in which quiescence is never reached because the tat is never weaker than the tit which evoked it. In other words, any incipient oscillation in the LCR circuit is augmented or maintained. This high-frequency alternating current is available for exciting our aerial, and needs but to be turned on and off by a Morse key to constitute a wireless transmitter.

The triode method is already very widely used for small powers—up to, say, 5 or 10 kilowatts input, but particularly for much smaller powers—and is likely soon to be applied in large sizes. *Fig.* 8*a* is a photograph of what is probably the largest triode transmitter yet constructed (the Marconi experimental set at the Canarvon station). There is here a panel of 48 triodes, each rather larger than that of *Fig.* 6; and the input from the high-tension source B may be 100 kilowatts or so at some 10,000 volts.

7.—RECEPTION.

So much for the transmission of the signal. Let us turn now to the process of perceiving the feeble æther waves which reach the receiving station whenever the operator at the distant transmitter depresses his Morse key.

For perceiving *very* high-frequency æther waves, those of light, man has evolved an extraordinarily fine type of receiving station which he builds all complete in his own head—his eyes. Our eyes, however, are not sensitive to frequencies below about ten million million periods per second; so that for perceiving the much longer æther waves of wireless telegraphy, we have to construct extraneous receiving apparatus on a larger scale. The function of this apparatus

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is to make the æther waves declare themselves in some way to which our sense organs—eyes or ears or others—are sensitive.

While the key at the transmitting station is down, we have a very tiny alternating potential gradient in space at the receiving station (and everywhere else)—perhaps a small fraction of a microvolt per centimetre of height. We therefore set up a receiving aerial, and tune it to the transmitter frequency so as to obtain in it as large a sympathetic alternating current as possible. It is this tiny high-frequency current which must be rendered perceptible to the receiving operator. I take the common case when perception is to be by the operator's ear held against a telephone receiver. If the aerial current were made to pass through the telephone, nothing would be heard, neither telephone nor human ear being sensitive for frequencies above a few thousand periods per second. We therefore "rectify" the alternating current before passing it into the telephone, as indicated in *Fig.* 9. The alternating

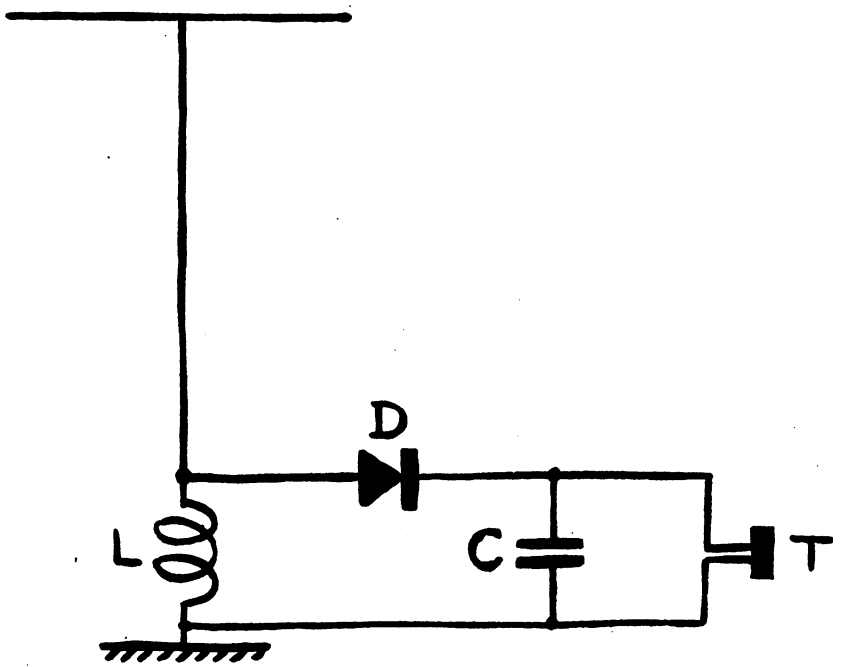

FIG. 9.

current in the aerial produces an alternating P.D. across the coil L, which P.D. is applied to the "detector" D *via* the condenser C. A "detector" is the (unsatisfactory) name for a rectifier, or asymmetric conductor, which allows current to pass more freely through it in one direction than the other. The condenser C therefore accumulates a charge, and a unidirectional current flows from it

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through the telephone, T. The form of the detector I will not discuss, except to mention that here again the thermionic tube is utilized.

The signal will thus produce a steady, and therefore still inaudible, current in the telephone ; whereas we want a current varying at some suitable acoustic rate. This is effected by mixing with the incoming signal of high-frequency n_1, say, a locally produced signal of slightly different frequency n_2, say ; so that we have a beat effect, a slow fluctuation of resultant amplitude as when two nearly-equal musical tones are sounded together. The rectified telephone current is then no longer steady, but fluctuates in amplitude at the beat frequency $(n_1—n_2)$. By adjusting n_2, the frequency of the local oscillator, the operator makes the beat frequency assume some convenient value, such as 1,000 periods per second. Then, while the transmitting-key is down, he hears a shrill musical note, and when it is up, nothing.

8.—INTERFERENCE.

Our wireless telegraph system is now complete, and by the short and long signals of the Morse Code, the transmitting operator can signal to the receiving operator, *if* :—

(*a*) the received signals are intrinsically strong enough to be audible ; and

(*b*) they are not drowned by undesired interfering signals.

These are big *ifs* ; or, at least, they both were until the advent of the modern triode amplifier made the importance of (*a*) vanishingly small compared with that of (*b*).

We have seen how in the triode the control over the anode circuit exercised by the grid potential may be made to produce oscillation ; and the adaptation of this control to give amplification effects is probably fairly obvious. As a fact, it is now ordinary easy practice to amplify an extremely feeble signal by passing it through the successive triodes of a multi-stage amplifier so that enormous amplifications are obtained ; and a signal, however weak at the input end of the amplifier, may be made of perceptible strength at the output end. *Fig.* 10 is a photograph of a well-known pattern of receiving triode used for such operations. It differs substantially only in scale from the transmitting triode of *Fig.* 6. Such triodes are used in large groups ; and it is clear that, if in each triode an amplification of the signal E.M.F. of, say, four times were obtained, a chain of, say, five triodes would give an amplification $4^5 = 1{,}000$ times—or, in terms of power, an amplification of $1{,}000^2$ = one million times. *Fig.* 11 shows a 7-triode amplifier (Marconi Co.), with triodes of a different external appearance.

I may remark in passing that the use of these powerful amplifiers

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enables us to dispense with expensive and inconvenient large receiving aerials, a small aerial plus amplifier serving as well as a large aerial without amplifier.

The difficulty, therefore, is no longer to make the signal strong enough to be perceptible, but to make it strong enough without at the same time making the disturbances strong enough to drown the signal. It is the second *if* which places the limit on wireless achievement to-day, and it is mainly in improvements in means of filtering signal from disturbances that any sensational advance is to be expected.

Of what, then, do these disturbances consist? They may be classified under two heads:—

(*a*) Signals from other wireless stations;
(*b*) Atmospherics or natural electric disturbances.

9.—Interference from other Stations.

As regards interference from other transmitting stations of the sort I have described, *i.e.*, "continuous wave" stations, sufficient protection is fairly easily got by the mere tuning or resonance properties of the receiving circuit. A lightly-damped oscillator, mechanical or electrical, responds very sensitively to slight amounts of mistuning of the rhythmic stimulus acting on it. This is illustrated quantitatively in a numerical case in *Fig.* 12, where the ordinates of the curve show the amplitude of the oscillation for various small amounts of distuning. It is seen that 1 per cent. of distuning here makes the response of the oscillator drop to about one-sixth of its tuned value. Much finer tunings, *i.e.*, more sharply peaked resonance curves, are easily obtained with electrical oscillatory circuits—dependent yet again upon the triode.

In order to enhance the selective property of the receiver, the simple receiving circuit of *Fig.* 9 is, in practice, complicated by the insertion of other tuned circuits, in the nature of successive filters, after the fashion of *Fig.* 13.

An interesting fact, of growing practical importance, is that the very process of keying a transmitter may cause more unwanted disturbing energy to be delivered to nearby receiving stations than if the key were held down continuously. That turning the transmitter *off* itself causes disturbance is a true—if at first sight somewhat paradoxical—statement, only to be explained properly in terms of a differential equation. This aggravation of the disturbance from other transmitting stations becomes more and more serious as speeds of keying are increased from the ordinary hand speeds of 10 or 20 words per minute to the automatic speeds of 100 words per minute and upwards now being demanded and, indeed, provided.

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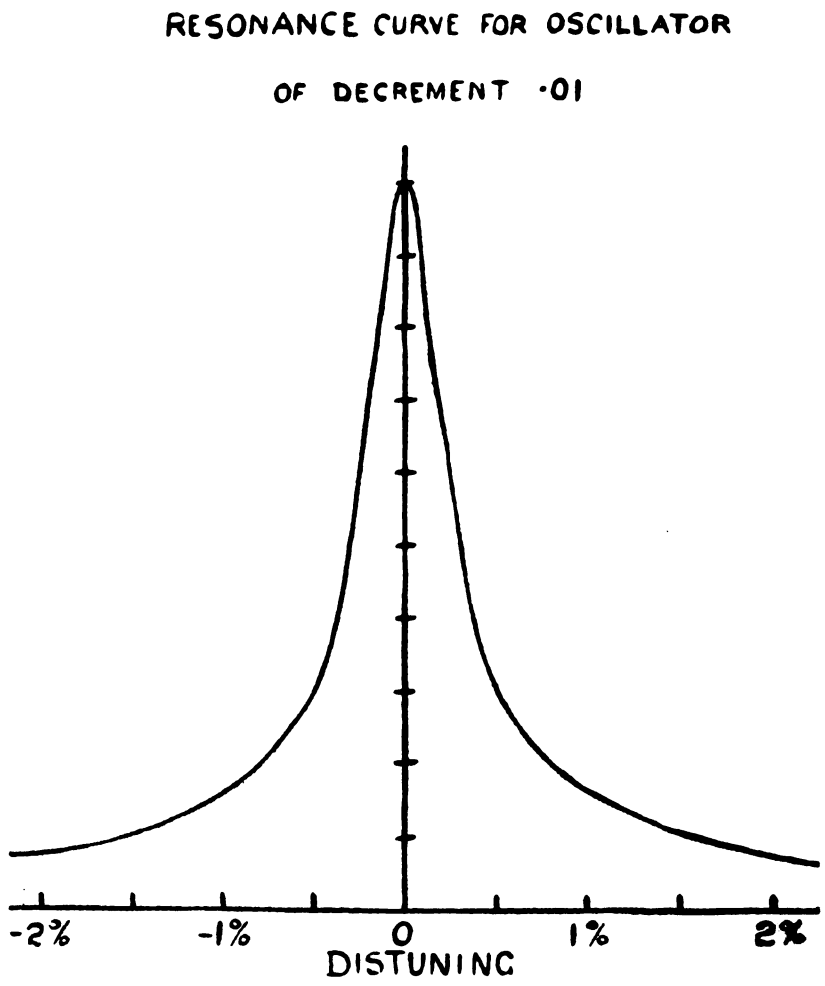

FIG. 12.

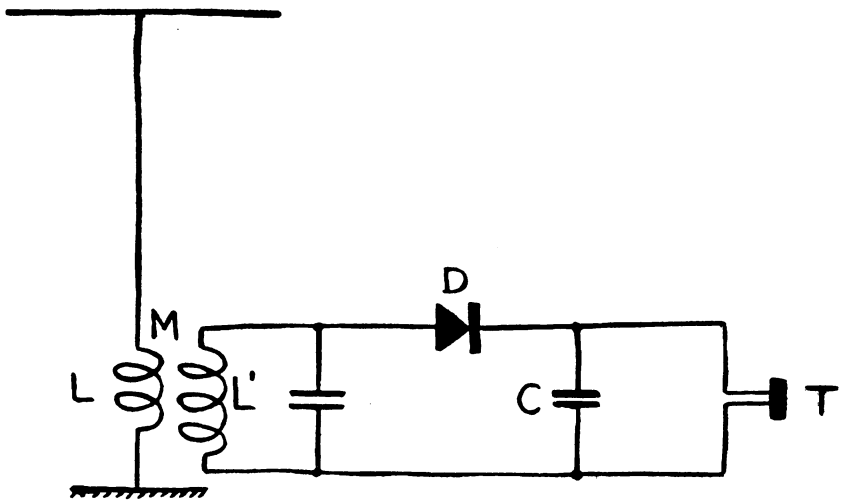

FIG. 13.

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10.—Atmospherics.

We turn now to disturbances of the second class, atmospherics. Just as any change of current in a circuit causes radiation, so any natural electrical disturbance in the earth or the atmosphere sets up a pulse which travels away and is competent, if strong enough, to affect receiving stations. The physics of the origins of these disturbances is very obscure; but, whatever the cause, they occur in some places with such violence and rapidity as to make wireless telegraphy, with apparatus hitherto used, quite impracticable during bad periods, which may last many hours per day on many days of the year.

It is probable that atmospherics arrive at the receiving aerial in great variety, but that they all give something in the nature of a violent shock to the receiving circuits and set them oscillating with their own natural frequencies. The one thing that the atmospheric clearly cannot be is a long-sustained isochronous periodic stimulus like that due to the transmitting station with key held down; so that it might seem that it must be possible to filter signal from atmospheric by resonance effects. The trouble is, however, that the signal must not itself be regarded as a sustained isochronous periodic stimulus. It must have a beginning and an end for each Morse dot and dash, and the transition periods with the long waves and high speeds of present endeavour have encroached until the whole Morse dot is nothing but a rise and a fall with no sensibly steady state in between. It is, therefore, not possible, even for the theoretician with paper and pencil in his study, to do more than *reduce* the disturbance by mere methods of fine tuning in the various ingenious elaborations which have fired and disappointed so many inventors.

11.—Method of Reducing Atmospheric Interference.

Beside tuning methods mainly relied upon hitherto, there are other lines of defence against atmospherics, which we may class as :—

(*a*) Atmospheric balancing;
(*b*) Atmospheric limiting;
(*c*) Directive reception.

All these methods involve in practice a weakening of the signal; but, with the modern amplifier, any device is welcome, although it enfeebles the signal, provided only that it enfeebles the atmospheric still more.

12.—Atmospheric Balancing.

Hitherto in this lecture, in conformity with all wireless practice until quite recently, we have contemplated receiving circuits precisely tuned to the incoming signal. Very interesting effects can, however, be obtained with combinations of distuned circuits.

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If I take two pendulums of precisely equal natural frequencies, and act equally upon each with a blow or a periodic force of any frequency, they are both set in motion exactly alike. If we imagine the two motions to be combined in such a way that the resultant is the difference of the two, we have an *in*-sensitive system. The two pendulums are to be thought of as two aerials, A_1, A_2 (*Fig.* 14), the resultant or combination effect being taken to the receiving apparatus R. Simultaneous equal currents in A_1 and A_2 produce no effect in R.

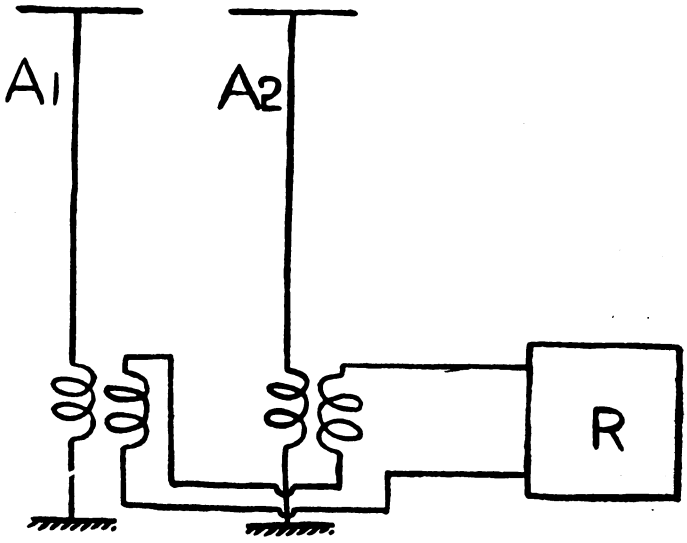

FIG. 14.

But if I distune the two pendulums a little in opposite directions (by shortening and lengthening them respectively), and act upon them with a rhythmic force of their former common frequency, both pendulums are set in motion, but now with a phase difference; one swings to the right while the other is swinging to the left. Our aerial combination is then sensitive to the rhythmic impulse, the incoming signal. If I apply a blow or shock, instead of the rhythmic force, to the pendulums (representing an atmospheric arriving at the aerials) both are jerked into motion, but *in* phase. Appreciable phase difference develops only later, when the motion has been to some extent damped down. The receiving circuit is thus protected from the early violent onslaught of the atmospheric, because in the initial stages the atmospheric balances out in the combining circuit. This anti-atmospheric device is of special interest in that it does not demand the use of circuits whose damping is small.

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13.—Atmospheric Limiting.

The reason for the incomplete success of resonance methods is that the atmospheric forces an ingress by sheer violence despite its handicap in not being tuned to the receiving system. If we could insert between the aerial and the ordinary selective receiving circuits some limiting device whose output could not exceed a certain limited amount, however great the input—like a slipping belt or a friction-clutch in mechanics—we could destroy the overpowering strength superiority of the atmospheric, and so exclude it in the subsequent filtering process.

This method—of course, not so easy to practise as to preach in these simple terms—is, in my opinion, of great promise. Here again it is to the invaluable thermionic triode to which we turn for an appropriate limiting instrument.

14.—Directive Reception.

Directive wireless receivers came into great prominence during the War, where they were largely used for locating enemy transmitting stations—for example, those on raiding airships. They depend on the use of a receiving aerial system which can be made *in*-sensitive to waves arriving from any particular direction, variable by the operator. The use of such a receiver gives protection against atmospherics, provided that the direction of the atmospherics is well defined and does not coincide with that of the desired signals.

Many forms of directive receiver are possible and practicable, the characteristic feature of them all being the use of two or more aerials spaced an appreciable distance apart. The spacing of the aerials A_1, A_2 in the plan view of *Fig.* 15 involves a phase difference

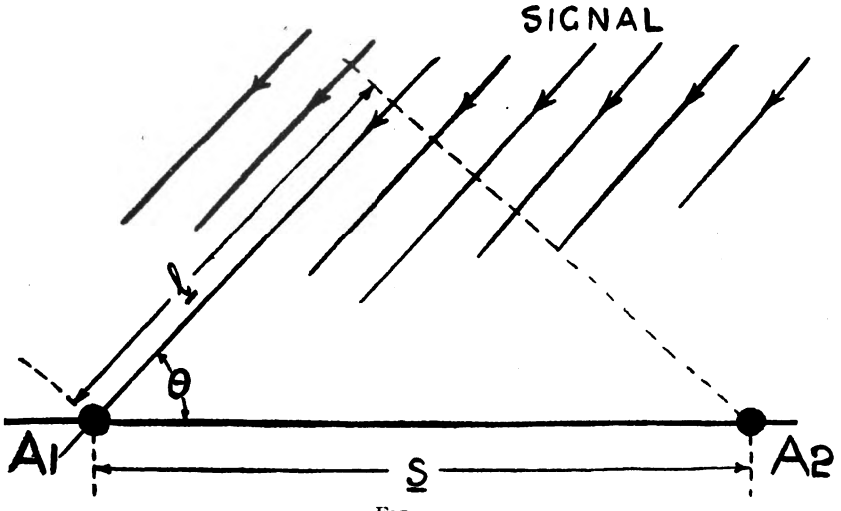

Fig. 15.

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of the E.M.F. impressed in them by the arriving signal, the difference varying according to the length l, from a maximum for the direction containing the aerials to zero for the perpendicular direction. Thus, if the two aerials are both tuned to the signal, the polar curve connecting sensitivity with direction of signal is a figure-of-eight as in *Fig.* 16. The length of the intercept r measures the sensitivity to a ray in the direction θ. There are here two blind directions, NO and N¹O.

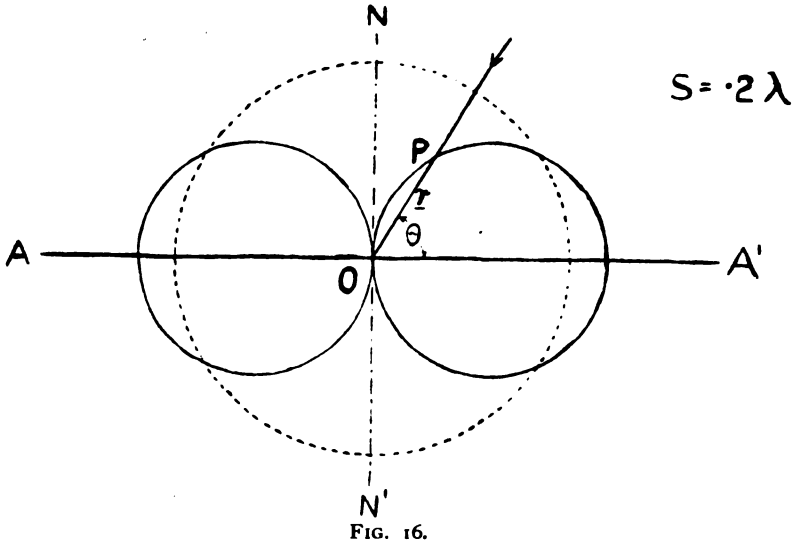

FIG. 16.

By distuning the aerials from the incoming wave we can make the resultant signal vanish for pairs of directions movable at will, obtaining sensitivity curves of the form of *Fig.* 17, where the two blind directions are ± 30°.

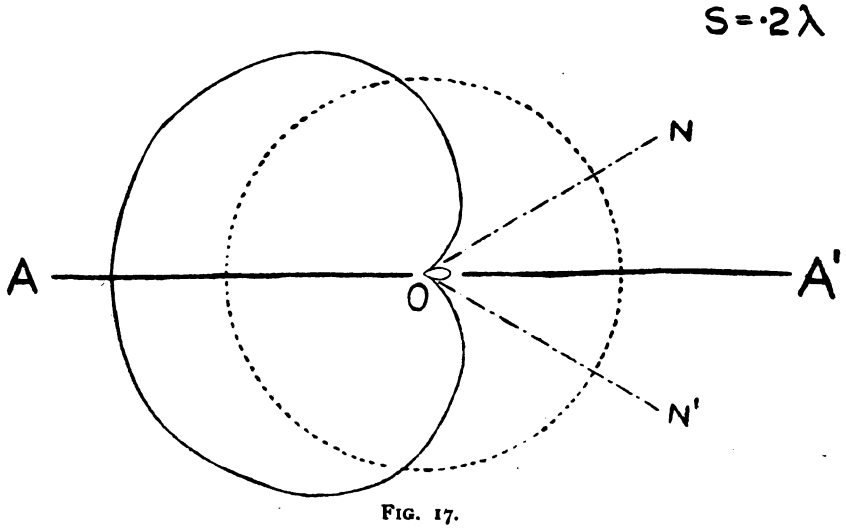

FIG. 17.

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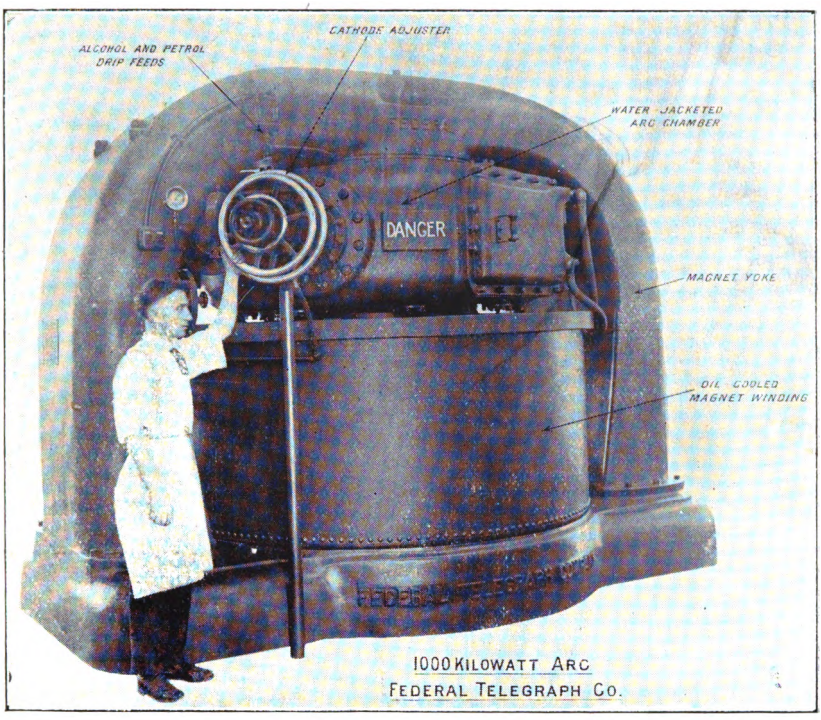

FIG. 3.

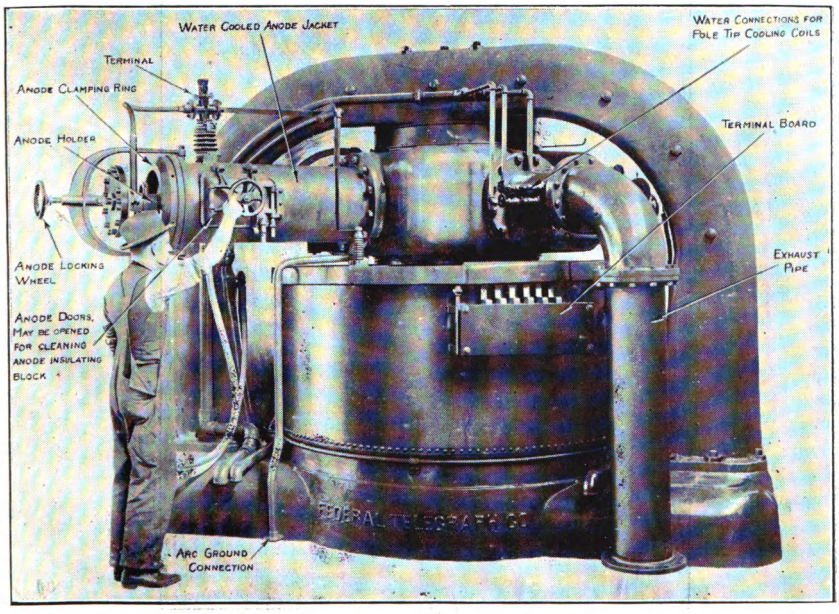

FIG. 4.

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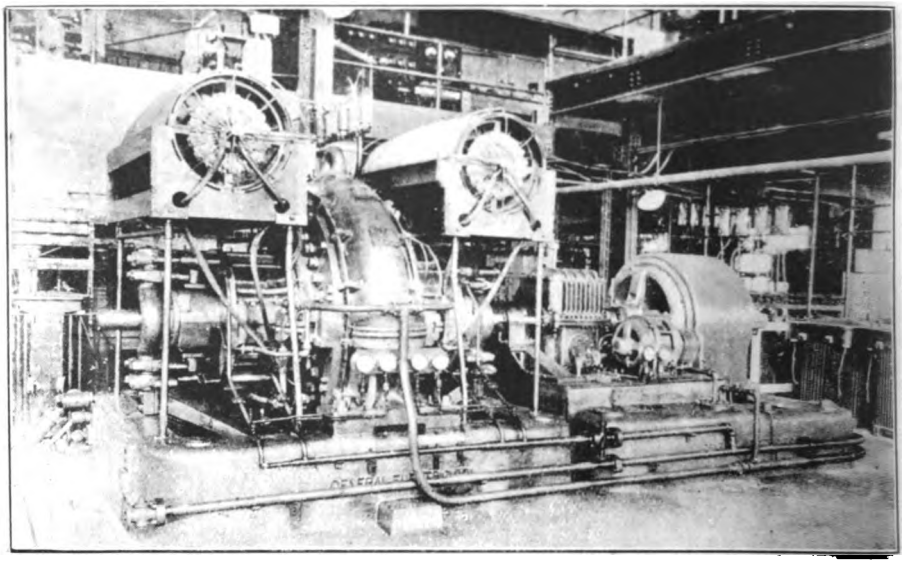

FIG. 5.

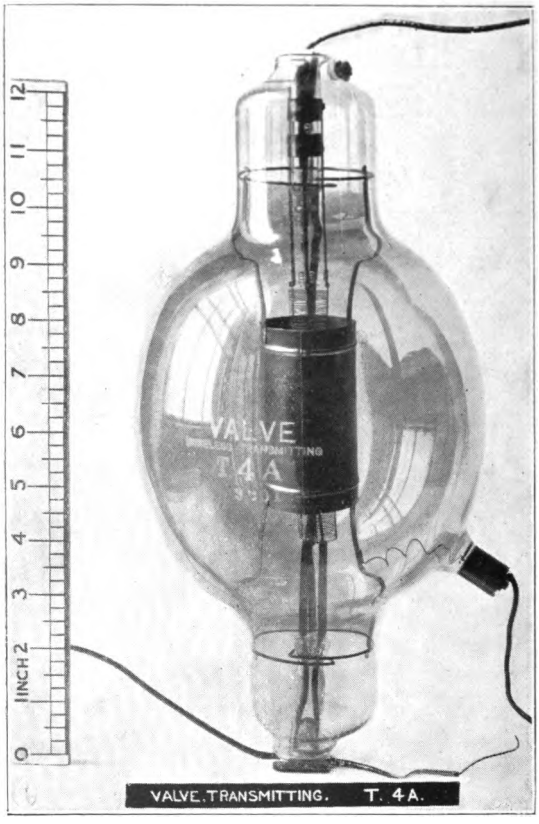

FIG. 6.

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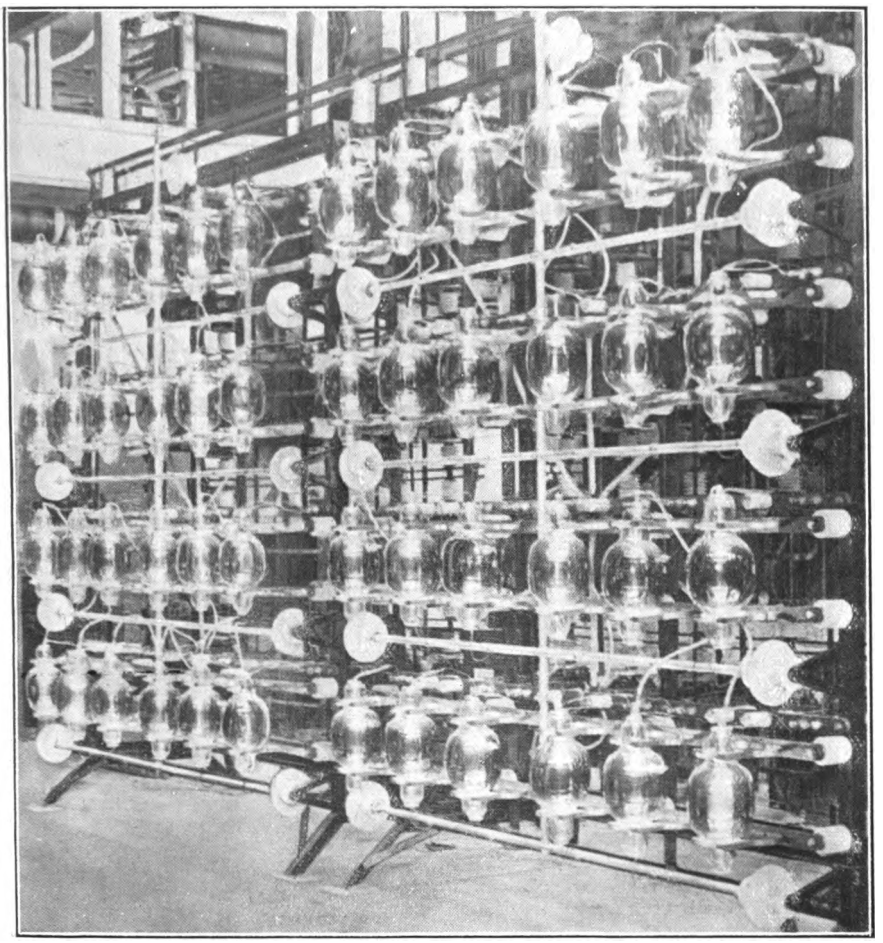

FIG. 8A.

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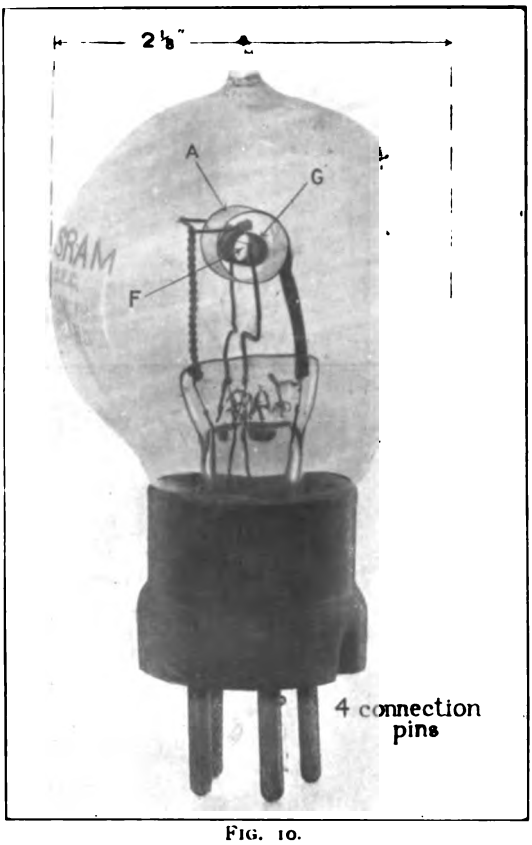

FIG. 10.

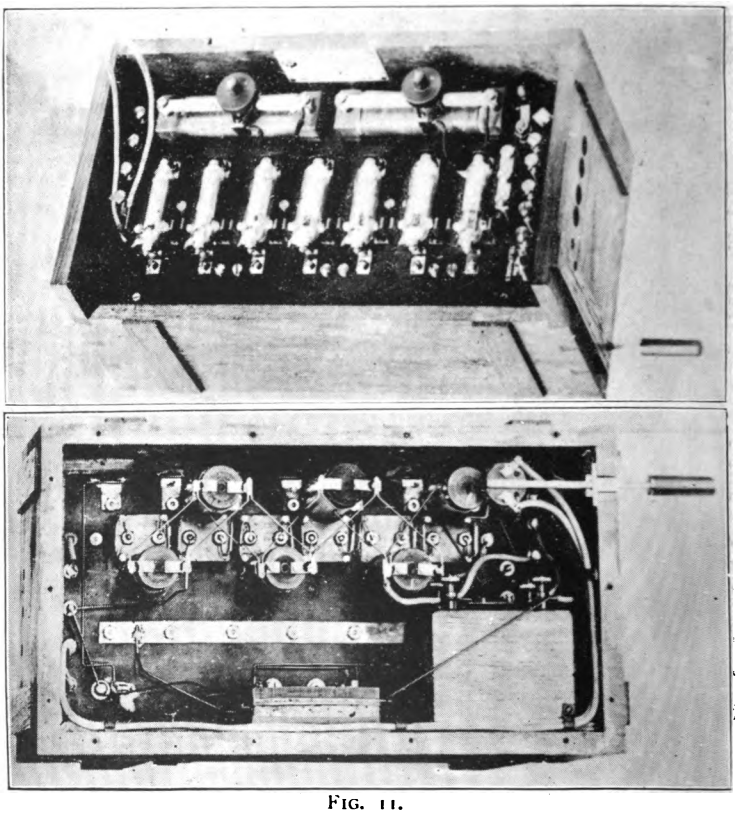

FIG. 11.

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15.—Conclusion.

Despite all these efforts at combating disturbance at the receiver, success has hitherto been very incomplete; and in tropical climates at least the atmospherics problem dominates the situation. I do not wish to seem gloomy, but probably any competent wireless engineer, unless in the throes of that well-known derangement, inventor's optimism, would agree that anything approaching complete protection against atmospherics is not likely to be reached in his day or generation. For atmospherics when they are bad are very, very bad; and to halve the number of unworkable hours during the year might require an improvement in protection, not twice, but perhaps a hundredfold.

An aggravation of the difficulty due to atmospheric disturbance is the other propagation phenomenon, the fading of signal strength, sometimes very apparent over long ranges. The opacity of the space between the two stations becomes at times much greater than normal, a phenomenon probably as incalculable and as unalterable as other meteorological conditions. The converse phenomenon, of exceptionally good propagation, is also well known, when fresh ranges are obtained, a small station being heard perhaps near its antipodes. The incomplete reports of such exceptional successes have been very misleading to the layman.

The directive effects obtainable, as we have seen, at the receiver can also, if economically desirable, be produced by corresponding devices at the transmitter; but whether the heterogeneous distribution of the radiation near the transmitter is retained at large distances is highly doubtful. In any case, it is to be noted that the directiveness hitherto obtained in wireless telegraphy is of a different order from the directiveness of, say, a telescope or a searchlight. A telescope is wholly insensitive to sources of light lying outside a certain cone; but the wireless receiver of, say, *Figs.* 16 or 17 is sensitive (though not equally sensitive) to disturbance from any quarter. A return to the concentrated beam technique of Hertz, practicable only with very short waves, may prove useful over short ranges, but does not appear feasible for long distances.

The Morse code, whose units are the simple on and off for long and short periods, may be likened to the key of a cheap lock with only a single ward. It is obvious that a more complicated code might be devised analogous to a good lock of many wards, which would not be forceable by the burglar atmospheric. But here, once more, speed of signalling is a fearsome barrier.

The favourite and undeniably fruitful method of getting signals through over greater distances and with fewer interruptions is to increase the radiation at the transmitter. Great advances have been made in this direction; but the economic is here a controlling factor;

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and, of course, the minor interference problem—interference from other stations—assumes a growing importance with enlargements at the transmitter.

The later portions of this paper may have, I fear, a rather pessimistic appearance; for I have dwelt upon the fact that the interference problem is a very tough one and still remains to be solved. But I am far from wishing to belittle the overwhelming advances in wireless achievement of the last few years, although I have given them small explicit mention here. They are such as to fill one with enthusiasm; and he would be a rash prophet who ventured to predict that obstacles at present apparently insuperable will never be surmounted or circumvented.

References to certain illustrative experiments carried out by the lecturer with pendulum models are here omitted.

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UMPIRING WITH ENGINEERS.

By MAJOR P. G. H. HOGG, D.S.O., R.E.

THE *Training and Manœuvre Regulations* (1913) has a chapter on "Umpiring," in which three sections give special points with regard to umpiring with Cavalry, Artillery and the Air Force; there is, however, no section dealing specially with umpiring with Engineers.

As Staff Officer to the Chief Umpire, Experimental Brigade, Aldershot Command (Major-General C. Corkran, C.B., C.M.G.), I was asked to draw up some notes on the subject. Colonel-Commandant R. N. Harvey, C.B., C.M.G., D.S.O., A.D.C., Chief Engineer, Aldershot Command, kindly looked through these notes and made some very helpful suggestions.

The notes are here given in their final form, as approved by the Chief Umpire and issued to Umpires, in case they may be of use to any officers having to carry out umpiring duties.

SPECIAL POINTS WITH REGARD TO UMPIRING WITH ENGINEERS.

1.—The work of an Umpire with Engineers calls for even a more vivid imagination than with other arms. Cavalry, Artillery and Infantry can move about, use blank ammunition and thus make a semblance of War; but Engineers, in peace, as in war, can do little without the expenditure of time and material; and, as there is seldom the requisite time and never a sufficient grant to carry out any but the simplest jobs on manœuvres, most works have to be left to the imagination. Thus the work of an Umpire with Engineers on manœuvres will usually consist in judging on the efficiency of execution of certain works which, owing to manœuvre conditions, cannot be carried out practically.

2.—The following list gives an idea of some of the works that might be required in war, divided among the various phases of operations, and which will have to be imagined in manœuvres:—

In Advance.—Engineer Reconaissance. Repair or construction of bridges from materials obtained locally, either by the demolition of barns and houses or by the felling of trees. Making deviations for tanks round unsafe bridges. The clearing of roads which may have been blocked (*a*) by mine craters; (*b*) by overhead bridges being blown down; (*c*) by felled trees.

The Attack or immediate preparation therefor.—Engineer reconnaissance. Making of gaps in hedges, railings, walls or fences. General preparations for any eventuality, *e.g.*, (*a*) success; (*b*) defeat; (*c*) a return to the situation in *statu quo*. Camouflage.

The Pursuit.—Similar to the advance, but the works will necessarily be of a more hasty nature.

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The Retreat.—Demolition of bridges. Blocking roads by mining or tree-felling. The putting of buildings into a state of defence. Destruction of railway tracks. Destruction of water supply.

3.—The question of Engineer reconnaissance should receive the careful attention of an umpire. A Field Company of Engineers carries a limited quantity of tools, but practically no stores, except explosives; in order, therefore, to carry out works in the field, Engineers are largely dependent for materials on the resources of the country in which they are operating. The only way to get information regarding these resources is by sending out small reconnaissance parties who must visit outlying farms and hamlets, find out what tools and materials are available and send in written reports to their C.O. In any cases affecting such reconnaissances, umpires should make a point of asking to see the reports in order to satisfy themselves that, not only has the reconnaissance been carried out, but that it could have been made out under war conditions.

It should be remembered that, with the exception of the officers, the personnel of a Field Company is dismounted and that the C.O., in order to send out parties to any distance, has not available more than one motor-cycle and 18 bicycles (*vide* Appendix Z, to accompany C.R.A.C. 2/83692/4 (G) dated 25. 4. 1922). Umpires must use their judgment as to the number of reconnaissance parties that can be sent out, the distance to which they could go and the time they must necessarily take.

4.—When the demolition of a bridge comes in as part of a rear-guard scheme, the umpire must be careful to ascertain that the responsibility for giving the actual order for firing the demolition charge has been delegated to some officer by name (see *Engineer Training*, 1922, Section 57, para. 6).

5.—In the case of the demolition of simple steel girder bridges, where gun-cotton slabs can be fixed to the girders without any structural damage to the bridge, such work should always be carried out practically, substituting dummy primers and detonators for the service article.

6.—In other cases the umpire must make use of Appendix F, *Training and Manœuvre Regulations* (1913), and will take great care before signing it that it represents a true statement of affairs; he must be certain that the necessary orders have been given and calculations made, that the working party, as stated, was present during the time mentioned and actually had all the requisite tools in its possession during that time (see *Training and Manœuvre Regulations* [1913], Section 71, paras. 4 and 5).

7.—The *Manual of Field Works* (All Arms), 1921, will assist an umpire in coming to a correct decision.

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PROFESSIONAL NOTE.

A RIVER-CROSSING SCHEME.

A Senior Officers' Class, for officers of all arms was held at the School of Military Engineering from 10th to 15th July; the last class of this nature having been held in 1914. One of the outdoor exercises was a scheme for forcing a passage across the Medway between Aylesford and Snodland. This proved to be a problem of a particularly interesting nature, illustrating the difficulties to be overcome in securing co-ordination between engineers and infantry in such a case. It is thought that its publication would be of general interest, so the details of the scheme are given below.

The subsequent discussion brought out several points illustrating special difficulties. One was a technical difficulty. With a 13 ft. difference of level between high and low tide, and a considerable stretch of mud on both sides of the water at low tide, would it be possible to devise and construct, within two or three hours of zero, a light bridge for wheeled transport which could be used at all states of the tide?

Some of the syndicates (all of which included R.E. officers) were in favour of trying it by means of a high trestle-bridge (lots of long timbers being handy), but the majority opinion was that it would take too long and that the interruption of traffic for two hours before and after low tide must be accepted until a second bridge for low levels could be constructed. The adoption of a pontoon, capable of sustaining its load when grounded, would meet such a difficulty as this.

Another question was one of organization. The question was asked: Assuming that the footbridges were made up under cover at some 400 yards' distance from the river-bank, who should be made responsible for the operation of carrying them to the crossing-places and launching them—the officer commanding the infantry battalion concerned, or the commander of the engineer section?

Some of the officers advocated the responsibility being laid on the commander of the engineers, on the grounds that the operations would be of a technical character beyond the competence of the infantry commander. These proposed that the infantry parties required to assist in carrying the bridges should be attached to the engineers, and put under the command of the commander of the latter, and that the officer commanding the infantry should stand aside from the operation until the bridges were reported to be in position, when he would order his men to cross them.

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Others were of opinion that the operation of carrying the made-up footbridge, launching it and passing over it were a tactical operation, with very little that is technical in it. They considered that the officer commanding the infantry should be responsible for the two bridges required by his battalion and that the necessary engineers for manning the leading bays of bridge, guying it while launching, etc., and repairing damages, should be placed under his orders. In favour of this course it was pointed out that only one section of engineers would probably be available to each battalion, that at the best its commander would be a subaltern and that it frequently happens from various causes that a section is commanded by a serjeant or even a corporal, that each section would have two bridges to deal with, so that at one—if not both of the crossing-places—the engineer commander would be a junior N.C.O. By putting the operation under the infantry commander it could be ensured that officers of some experience and seniority would be in charge at each bridge-crossing. Previous reconnaissance by the infantry officers concerned and explanations from the R.E. would enable them to understand what they had to do. Previous rehearsal of the operation in a rear area would be advisable.

This point elicited an interesting discussion, the majority (but not the whole) of the infantry officers present being in favour of the first of the two courses described above.

ATTACK SCHEME.

(River Crossing.)

Reference 1 *in. O.S. Map Sheet* 116.

Narrative.—A Westland force, based on London, having been forced to withdraw from a defensive position in the neighbourhood of Sittingbourne has retired west of the Medway.

On the evening of the 12th July the Eastland force, of which the 3rd Division forms a part, has reached the line Chatham–Maidstone.

Information has been received that all the bridges across the Medway from Chatham–Maidstone (both inclusive) have been destroyed and that Westland intends to make a stand west of the river.

During the 13th July, by minor engagements, the whole ground east of the river is cleared of the enemy's posts, and the G.O.C., Eastland Force, determines to attack the enemy's position west of the river on the early morning of the 18th July.

Boundaries of the 3rd Division are as follows :—

North.—Burham–Snodland–Paddlesworth (all exclusive).

South.—Lower Bell Inn–Aylesford–Cobdown–Main Sevenoaks Road (all inclusive).

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First Objective.—Line of railway from Snodland–New Hythe–Borough Court–Cobdown.

Second Objective.—Rookery Farm–Lunsford–Larkfield.

Attack to be on a two-brigade front. Dividing line: Eccles–New Hythe–Lunsford (all inclusive) to right brigade.

During the afternoon and evening of the 13th the G.O.C., 3rd Division, accompanied by his C.R.A., C.R.E. and G.S.O.I., makes a personal reconnaissance of the river.

The following information is available:—

(*a*) Intelligence report on the River Medway, from Aylesford–Snodland.

(*b*) Aeroplane photos.

(*c*) Maps, O.S., scale—6 in. to one mile; sheets XXXI N.W. and S.W.

INTELLIGENCE NOTES ON THE RIVER MEDWAY, FROM AYLESFORD TO SNODLAND.

General Details.—The river follows a winding course in a flat, marshy valley, about one mile broad.

The valley is overlooked by high ground on both banks. On the east from the Bluebell Hill ridge, about 1½ to 2 miles away and 500 ft. high. On the west from high ground, which is rather further away, 2 to 3 miles, and somewhat lower, 400 ft.

The country is cut up by small plantations, scattered houses and cement works.

Details of River.—The river is tidal with a rise and fall of about 13 ft. at Snodland (Spring Tides).

Depth at low water, 5 ft. to 6 ft.

Width: Aylesford, 159 ft. (high water);
Snodland, 220 ft. (high water).

Bed, deep mud, with occasional harder patches.

Banks: On each side of the river are marshes which are below highwater level, but in many cases have been reclaimed and drained, the water being kept out by dykes. The marshes are intersected with drainage channels.

The cement works and brick works along the river have wharves for barges where the banks are revetted (often with concrete) and firm.

Strength of current at half-tide about 3 knots.

Probable Approaches.—

(1) Aylesford Bridge.

(2) Court Lodge; thence past western edge of the Friars (west of Aylesford).

(3) By path running down to east bank, 200 yards south-west of Sewage Works (Maidstone Corporation).

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(4) By track from Rowe Place (500 yards south of Eccles), northern edge of Bushey Wood–southern edge of West Kent Cement Works to river bank opposite New Hythe.

(5) By track from Eccles to Burham Brick Works.

Of the above, metalled roads are available on the far sides at (1), (2) and (4) only.

Special Features.—The North Kent Railway line runs parallel to the general line of the river on the west bank.

This is a double line of railway, carried on an embankment across the marshes. Height of the embankment at Snodland, about 8 ft. above the general height of the marshes.

Fords.—At Mill Hall and New Hythe, the river is fordable at extreme low water. The bottom is hard shale and shingle, and the depth of water, 18 in. to 2 ft. This condition only lasts for about half an hour.

There are two level-crossings at Aylesford Station and one at New Hythe, and ramps leading up the embankments 600 yards south of Snodland Station.

Where footpaths are shewn passing under the railway, the culverts give about 8 ft. 6 in. headroom and 9 ft. width.

The big drain running west of the railway south of Snodland is reported to be about 14 ft. wide.

Snodland Common consists of marshy ground, and is intersected by small drains.

The enemy have sunk all barges, boats, etc., on the river.

Note.—Sunrise: 0506 (Summer Time) on 18th July, 1922.
Full moon: 9th July.
High Tides: 18th July, 1922, 0631 hours.

I.T., S.M.E.

4. 7. 22.

Problem I.—As C.R.E., carry out the reconnaissance of the river, and report for the information of the G.O.C. what arrangements can be made for getting the infantry, field-guns and horse-transport of the Division across the river and where the best crossing-places would be.

Also, roughly, the number of men that can be got across by the end of one hour and by the end of two hours after work commences.

Problem II.—On the assumption that the G.O.C. approves of your suggested arrangements, what orders would the C.R.E. issue to his companies to carry these out.

Note.—Syndicates of six will be divided into two, one-half to work up stream from Burham Court to New Hythe and the other half down stream from Aylesford to New Hythe.

Meet New Hythe Ferry, east bank, 1300 hours with one combined solution per syndicate.

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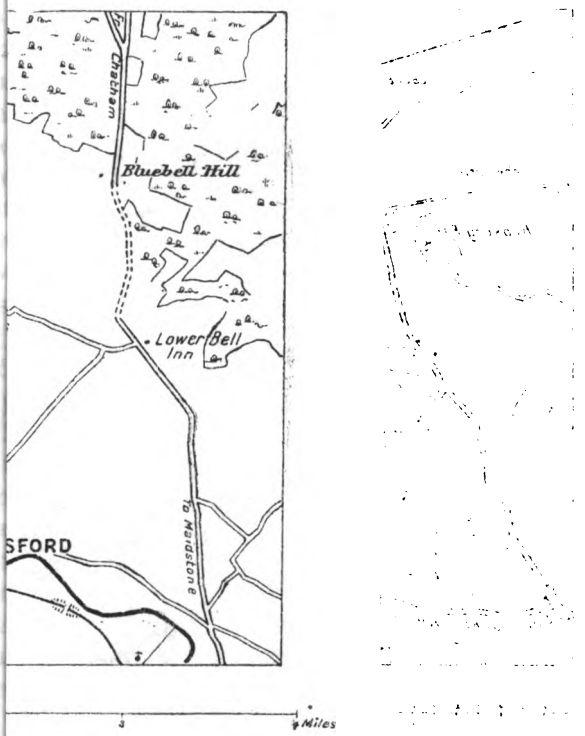

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THE TACTICAL THEORIES OF CAPTAIN LIDDELL HART.

(*A Criticism.*)

By BT. LIEUT.-COLONEL L. V. BOND, R.E.

1. ALL who are interested in infantry tactics will be grateful to Capt. Liddell Hart for the résumé of the French Infantry Regulations which he has contributed to the issue of the *Royal Engineers Journal* for May, 1922. The solution of the difficult problems of the handling of infantry under the conditions of war for which our Allies have to provide cannot but be of extreme value to ourselves.

2. The task of criticizing his ideas is one of some delicacy, but it appears, nevertheless, to be a task which it is permissible to attempt. The confident and oracular tone of his pronouncements invite assault. I could have wished that one better qualified than myself would have attempted the task. But the time has fully arrived when the attempt must be made.

3. It will generally be admitted, it is indeed a fundamental truth, that no system of tactics can be sound which does not take into account the physical and spiritual nature of man.

War—as Marshal Foch so continually insists—is not a game of chess, an affair of lines and angles, or of diagrams. It is, on the contrary, a chaotic business, " a dreadful and impassioned drama " which displays and exploits all the strengths and weaknesses of human nature.

No system of tactics can, therefore, be sound which does not react correctly to every *human* test.

No system of tactics for the British Empire can stand which does not bear the impress of the racial characteristics of our fighters; of Private " Nobby " Clark, brave, careless, improvident, tenacious, irrepressible, but not gifted in the mass with any great brain-power or initiative; of Lance-Corporal " Alf " Skinner, of Corporal " Dusty " Millar—magnificent fellows, but not all gifted with the *coup d'œil militaire*; men who share in a very full measure the Briton's love for *jargon*, for catchwords as a substitute for tactical thinking; of Sepoy Thakur Singh; of Naik Kamaluddin; of Jemadar Ramji Lal; of Subadar Bir Bahadur.

These, in conjunction with vigorous individuals from the Dominions; these—and not guns, or rifles, or tanks—are the principal weapons with which our armies fight. And the characteristics of these weapons must be the foundation, as well as the criterion, of our tactical teaching.

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No one will be found to dissent from this proposition; to do so would be to argue that there is no difference in military characteristics between men of our race, of the French, the Russians and Portuguese—which is absurd.

Yet one may search Captain Hart's lectures almost in vain for any sign that he recognizes the fundamental importance of the human factor. Equally vainly may one search his recent article in the *Journal* for any hint that he realizes that what is true for the Briton is not necessarily true for the Frenchman, or that what is possible for a long-service army is not, perhaps, possible for a short-service army.

I will readily admit that the article which he has contributed to the current (May) number of the *National Review* strikes a much truer note than any of his previous work. But I am at present concerned mainly with his system of tactics—his "man-in-the-dark" theory—and this, failing further explanation, must stand or fall by his lectures.

4. Nothing is more remarkable in the tactical work of officers in these days than the difference in outlook of the true "front-line soldier" and of the "back-line soldier." Where the latter quotes the Regulations and Pamphlets, the former refers continually to the men: such and such a manœuvre is all very well in theory, but the men won't do it: a method looks all right, but, as a matter of fact, the men will be much more "for it" if another method is followed: it is no good talking about so and so because you won't be able to get your orders to the men. This objective outlook is the basis of all the reasoning of the "front-line" soldier; and such objective reasoning alone can provide a true basis for tactical theories.

5. And, if it is true that our tactical theory must take account of the psychology of our men, it is equally true that the interpretation of that theory into practice must vary not only with the nature of our own organization and armaments, but with the general character of the theatre of war, and yet more with the nature, armament and fighting methods of our enemy. The method which was perfectly suitable against the German of 1918, under the conditions of 1918, might well have been unsuitable in 1914: it would even more probably prove unsuitable, if not altogether impracticable, were we to have to fight the Afghans in 1923.

To take an example of this elementary truth, Captain Hart proposes as a "maxim" that, in the presence of unlocated enemy, the leading sections should always send ahead a couple of scouts. That may be true of most forms of warfare, but to teach such a rule on many parts of our N.W. Frontier of India would lead to the certain loss of two men and two rifles with no useful result.

In another "maxim" Captain Hart lays down the rule that battalion and infantry brigade-commanders will move with their

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support unit until this is engaged and will then move with the reserve unit. This rule may have been true for battalion-commanders in France in 1918, though even this is very much open to argument. It is certainly not true for the valleys of Waziristan, where, if he would control his unit and be controlled by the higher command, the battalion-commander must move by bounds and must select his successive command-posts in places from which he can see. The rule is yet more untrue for brigade-commanders in the hills, while few brigade-commanders will admit that it was invariably true, or even generally true of the conditions of France in 1918. The choice of the command-post, in fact, depends on a large number of practical considerations which Captain Hart conveniently and totally ignores.

6. I repeat, then, that the objective outlook is sadly lacking in the lecture in which Captain Hart develops his system. Nor is there anything to show that his theory has been tested and that it reacts correctly to the human test under every variety of conditions.

I do not say that he is invariably wrong; there is, indeed, very much good sense in what he says; but I do say that he will not carry conviction until he supports his argument at every step by reference to the actual experiences of himself and others.

Every war is distinguished by a series of special conditions, of facts which must be faced. It is through ignoring this simple truth that Captain Hart comes most heavily to grief.

7. The outbreak of a new jargon is a phenomenon observable after every considerable war. The Great War has brought no exception to this rule. Thus, Captain Hart and many others repeat with a certain unction, as embodying new lessons of the late war, such phrases as "soft spot tactics." It is observable that the *Infantry Training*, as issued, avoids the use of this disastrous catchword. Yet, if Captain Hart were to have his way, we should, I fear, continue to see bodies of dejected men roaming about "looking for a soft spot," or platoons contentedly "held up" (another catchword beloved of Captain Hart), because the spot they have found is not quite so soft as they would like it to be.

8. The truth is that "jargon" is a disease to which we are all subject, and that Captain Hart has suffered a somewhat severe infection. He talks continually of "modern conditions." It is on modern conditions that he raises the whole structure of his system. What does he mean by modern conditions? He means the condition of things which obtained in France in 1918, a condition characterized by the possession by both sides of vast armaments and of practically unlimited gun ammunition.

9. But, in war, it is with the particular conditions of each particular case that we have to deal, with stark facts that must be faced,

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that must be taken into account, that cannot be charmed out of our path by even the most euphonious of catchwords. It is, therefore, for the facts of their immediate future that we must prepare our infantry; not for the conditions of the past.

When Captain Hart builds his theory on the widely-dispersed defensive groups which were characteristic of the fighting in France in 1918, he builds a theory which will, *prima facie*, only be applicable, and, failing further investigation, must be held to be true—if indeed it is true at all—only in the conditions which obtained in France in 1918. When he goes further and deduces from his theory, for universal employment, rules and formations and set forms, he threatens to become a public danger to all who are training for war under other conditions.

10. Captain Hart tells us that the system, as defined in the lectures published in the *R.E. Journal* for April and May, 1921, is intended to be a framework of tactics adjustable to all the normal situations of battle, a system in which our leaders can be drilled until to apply its "maxims" becomes a habit.

He suggests that his idea of creating such a framework is both daring and novel. Daring certainly it is, but novel it most certainly is not. It has been a constant phenomenon of all wars that the so-called lessons tend to crystallize into some such system which remains unchanged and generally unchallenged until it is washed away in blood by the "abnormal" conditions of the next conflict. The geographical strategy of the Austrian, and the oblique order of battle of the Prussian broke down before the commander who ignored the "rules of war." The battalions which, in the Peninsula, could "go anywhere, and do anything," failed to live up to their reputation when transferred to the American scene.

Indeed, up till quite recent times, the "absolute form," as Jomini calls it, or the universal framework, has always been a characteristic of our text-books. Before the South African War—if my memory serves me—we had a very definite system. We deployed in three bodies: a firing-line extended at two paces, supports in single rank, reserves in close order. Each body reinforced the firing-line as the advance progressed, until we had built up a dense firing-line for the assault. We certainly—in my college cadet corps—drilled very smartly in some such system. It was, presumably, a lesson of 1870. Probably the Germans and the French were practising much the same thing, with this difference that, whereas in the assault we shouted "Hurrah!" the German cried "Hoch!" while the Frenchman, raising his *képi* on his bayonet (a fascinating manœuvre), cried himself out (*s'écria*), "*en avant à la baïonnette!*"

Whatever the system may have been, the period of warning which preceded the outbreak of the War did not suffice to produce an

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official admission of its unsuitability to the special conditions of South Africa; "yet," says Colonel Henderson,* "our officers realized, before even a shot was fired, that what they had practised in peace was utterly unsuited to the Mauser-swept battlefield."

Since then wiser counsels have prevailed. But there is still a danger of the misapplication of unsuitable methods, if our text-books fail to distinguish with the most unmistakable clearness between what is universal and what is merely special to the particular case, the conditions of which must be clearly defined.

11. There is, then, nothing novel in Captain Liddell Hart's idea of an universal framework. It is a manifestation of the same old phenomenon. The false lessons of a war are embodied in a more or less rigid system, the true lessons are forgotten—if, indeed, they are ever formulated.

The forms, the methods, the jargon which are the product of the special conditions of the War survive, the lessons which are true for future wars are lost. Why is this? It is because the forms are tangible, men have been drilled in them, they can be embalmed in diagrams; because jargon is a refuge from thinking and is, therefore, acceptable to the mass of men. The true lessons are avoided because they are of their nature spiritual, difficult to express, difficult to teach, impossible to draw.

What, then, are the true tactical lessons of the Great War? I say, unhesitatingly, that they are the same as for every war in which we have been engaged. We should have learnt three things: the psychology of our soldiers, the material and moral effect of existing weapons in various circumstances, the necessity at all times of thinking objectively, that is to say, of basing action not on theories —on what we should *like* to do—but on the hard facts of the particular case—on what we *can* do.

It would, doubtless, be possible to elaborate these lessons; but of lessons of universal application, these are, I think, the chief. Armed with this knowledge, with this habit of thought, with the true spirit of the basic principles of war, and with the will to win, our leaders ought to be certain of victory wherever their duty calls them. Equipped with the purely mechanical system of Captain Liddell Hart, based, as it is, on conditions with which, as we have lately been authoritatively informed,† "we are unlikely to meet again," we court defeat in nine cases out of ten.

12. It will, perhaps, have dawned on the reader—if he has been able to follow me thus far—that I hold Captain Hart's so-called

* See *The Science of War*, page 372.

† Mr. Winston Churchill recently stated that the War Office policy was based on the improbability of another "national" war within the next ten years. And in ten years, what changes must there not be in our armament, our organisation and our tactics!

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science of infantry tactics to be based on error. And it can reasonably be argued that a system based on error cannot but be false.

Even his initial simile of the "man-in-the-dark" I hold to be erroneous, since it presupposes that the man and his opponent are more or less similarly armed and similarly situated. Yet, similarity of armament, of organization and of technique are not normal conditions in the wars of our Empire.

There is always this danger in the use of analogy—that we may be tempted to press the parallel too far. Captain Hart has done so. We must, if we wish to use this form of argument, make sure that what we assume to be "likes" are not, in fact, "unlikes." Captain Hart has failed to take this necessary precaution. He tells us, for example, that he deduced his system of penetration from a study of Nature's method in the bursting of water through an earthen dam. Yet, can there be anything more unlike than inanimate water bursting through a passively resisting dam, and a trickle of tired men, torn and bewildered by the psychological impact of battle, passing through a gap in an actively resisting hostile front to meet fresh, unknown and unlocated dangers ahead? The two things are totally dissimilar.

Equally well might Captain Hart have used the successive impact and retirement of the waves of the rising tide as an argument for a perpetual leap-frogging of fresh units in the attack. Or, better still, he might have "deduced" from the action of one of those rotary brushes, which remove with such exquisite precision the sludge of a London street, a system distinguished by an oblique order of battle combined with a continuous *roulement* of platoons within the battalion. The train of reasoning in the latter analogy would have been no less sound than that of his "expanding torrent," while it has this supreme advantage—that it permits of the use of a French catchword, the pronunciation of which is particularly soothing to the palate.

I do not wish to press the point too far. But I trust that I have said enough to show that, in basing his tactical theories on expanding torrents, Captain Hart has, consciously or unconsciously, attempted to dope us with flap-doodle of the most misleading kind.

13. Rashly ignoring the fact that the authority which he quotes has itself laid down that war is an art and not a science, and that it is therefore not subject to rigid rules (*F.S.R.*, Vol. II, Sec. 3), he tells us that he intends to build up a "science of infantry tactics." Careless in his use of analogy, he is, it is to be feared, equally careless in his use of terms. Science has but one method of procedure, and that is invariable.* It aims first, with a just and open mind, at the collection and correct observation of facts—of phenomena. It

* See Chap. II. of *The Psychology of Insanity*, by Bernard Hart.

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proceeds then to classify these phenomena into groups or series. Finally it endeavours to find a formula which shall explain all these facts, which shall be universally true for all the observed phenomena. Produce one instance where the formula fails and there is no science. A science must be universal or it cannot exist. Yet Captain Hart's system, as we have already shown, owes nothing, as far as we have been allowed to see, to the patient collection and examination of actual phenomena. On the contrary, it appears to be the result of pure theory unconnected with experience.

Nor is it, in its nature, universal; since, as we have also seen, it is based on the consideration of one special case, namely, that resulting from a struggle between armies, each provided with vast armaments, a condition of things which, as we know, implies the complete mobilization of the national life to the business of war. This is not a normal condition in the wars of our empire. It is not a condition which we are likely to see again for some time. It is not a condition which is normal to the commencement of any great war.

Captain Hart's so-called science is, therefore, not universal in its nature. Nor, as we have already seen, are the formulæ which it proposes true of all cases with which it deals. It is, therefore, not a science, but a non-science.

14. I do not wish to be so dogmatic as to say that there can be no science of infantry tactics. But I do insist that such a science must be universal and must therefore be based on the phenomena which are common to all wars. What are those universal phenomena? They are those which Napoleon intended that we should find when, in comparatively modern times, he recommended the study of the campaigns of Alexander, of Cæsar and of Hannibal. They are the phenomena due to whatever is universal and unchanging in the nature of man.

All men have the instinct of self-preservation; all are susceptible to fear, to hunger, to cold, to fatigue, to discouragement, to death and wounds; all are probably susceptible to the fear of encirclement, of the attack in flank while engaged with an enemy in front; all are liable to the panic which is the child of surprise.

If, then, there is to be a science of infantry tactics, it is upon the observation and classification of these and similar phenomena that it must be built up. I do not find these matters anywhere mentioned in Captain Liddell Hart's lectures.

15. In truth, to construct a theory of tactics, it is not sufficient to draw on maps, pre-arranged for the purpose, a variety of objects generally resembling bifurcated tadpoles. Tactics are a matter appertaining to human nature; they cannot be compounded of paper and printer's ink. His recent article in the *National Review* shows that Captain Hart realizes this as well as do the rest of us. But let

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the reader look at the four plates illustrating his "expanding torrent" system which follow Captain Hart's lecture in the *Journal* for May, 1921. Replace the brainy and bifurcated tadpoles by the men whom we have tried to describe, men brave, but not brainy; men who are stunned or controlled by the psychological impact of battle; men whose main idea—if it is not to find "a better 'ole"—is to finish their bit of the job and to consolidate themselves while others take up the advance. Replace the heads of the tadpoles by leaders who seldom can have any certain knowledge of what is happening, whose main idea is, perhaps, not to "lose the barrage"; who, if they have conceived a plan, may be struck down before that plan is communicated. Take this picture, and a variety of practical questions present themselves—questions which cannot be solved by an appeal to an "expanding torrent" or even to the more attractive "rotary road brush."

Can the platoon leaders know enough of the situation to manœuvre with the necessary skill?

If not, to what extent can the company-commander expect to control his platoon-leaders?

Under the effective fire of the defence, as they must be if there is no overwhelming attacking artillery, can platoons be induced to manœuvre to a flank?

If not, what are the limiting conditions of fire for this to be possible?

If we have an overwhelming artillery, which must of its nature function on a timed programme, how will these complicated manœuvres and the doctrine of free-will for platoon-commanders fit in with the advance of the barrage?

To what extent are we sure that a platoon which has performed one task will voluntarily proceed to another?

In view of the supreme difficulty always experienced in keeping direction, what are the chances of, say, No. 7 Platoon, after its circuitous wriggle, starting off again in the right direction?

It being natural for human beings to move either in line or one behind the other, could the arrow-head formation really be retained by sections during these wanderings?

What about the supply of ammunition, bombs, etc., to the platoons destined eventually to push right through to the battalion objective?

Who decides when a platoon is exhausted, and, therefore, under Captain Hart's scheme, excused from further pressing forward to the battalion objective?

And so on.

16. I may be wrong. I trust that I am wrong. But it certainly does seem to me that the highly complicated manœuvres illustrated

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in these *Plates* can only succeed if we assume the following conditions, viz. :—

(*a*) an enemy in widely separated and distinct posts ;
(*b*) a perfect knowledge of the positions of those posts ;
(*c*) leaders who can be relied on to take correct tactical decisions ;
(*d*) no time-table to adhere to, as with a barrage ;
(*e*) troops under complete control, and ready and willing to attack a series of objectives ;
(*f*) a passive enemy.

I presume that Captain Hart writes from experience. And I shall certainly not accuse him of proposing what he knows from experience to be impossible. I must presume, therefore, that these conditions were found on the Western Front in 1918. I am glad to know it. It is news to me.

But I cannot think of any probable war in the near future in which several of these conditions will not be absent. I conclude, then, as before, that Captain Hart's universal system of the " expanding torrent " is not universal. And if this theory fails at the practical test, it furnishes strong presumptive evidence that, whatever other theories he may have based on similar arguments should also be similarly examined.

17. There are, indeed, many *dicta* among his writings of which we should like a fuller explanation, supported, if possible, with instances from his experience.

As engineer officers, and peculiarly interested in theories of defence, we should like to know more of the working of the system illustrated by the sketch on page 220 of the *Journal* for May, 1921 : a sketch which, by the way, contains in its bottom left-hand corner, our old friend of " shop " days—the " impossible contour." What, for example, happens when the attacker ignores—as he may well do—the advice of Captain Hart, and breaks through in the left-hand half of the sketch, or along the whole of the battalion front ? Will this not provide an unpleasant surprise for the manœuvre platoons shown as distributed in posts presenting their flanks, if not their sterns, to the break through ? Captain Hart bases his system on the supposition that " the phase of fixing is carried out by the forward bodies." How does he reconcile this with the system of *F.S.R.*, Vol. II, which is based on the lesson of experience, that, under " modern conditions," the troops in the outpost or forward zone cannot be expected to fix the attack ? The two systems are irreconcilable,

To take another instance : many officers of experience would wish to hear further arguments on the subject of the " unlimited objective." They are aware that, in theory, the limitation of the freedom and of the objectives of units is to be deprecated. But they were under the impression that it was the insuperable argument of

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facts that had forced us to the conclusion that, wherever strong and active resistance in depth was to be expected, control could only be ensured by allotting definite units to definite objectives, by limiting objectives, by attacking fresh objectives with fresh troops; and they understood that it was the number and nature of the objectives which determined whether or not this system should be carried down to the platoon. The arguments for this view will be found stated with great authority on pages 36 to 39 of Lieut.-General Sir G. M. Harper's *Notes on Infantry Tactics and Training;* arguments which, I must invite Captain Hart to notice, are based solely on practical considerations. Those arguments apply to France. But they have proved equally true of Mesopotamia. While an examination of recent campaigns in Waziristan will show that leap-frogging by companies and platoons, with the consolidation of limited objectives—a system long in use on the frontier—is even more necessary now than it used to be.

To this body of argument Captain Hart has, so far, opposed a single paragraph which is to be found on page 181 of the *Journal* for May, 1921; a paragraph which is typical of the method of his lectures. Readers who care to refer to it will find that it consists of a handful of jargon strung together on an argument of amazing inconsequence. There is in it nothing of experience; nothing of the practical outlook. We want something better than that to convince experienced officers.

18. It is true that, in support of his point of view, he quotes in his recent article a phrase from the French Infantry Regulations. Speaking apparently of the handling of reserves, these Regulations say: "every unit ought to pursue its effort to the full limit of its offensive capacity." We cannot say, without seeing the context, whether he is justified in taking this to support his doctrine of the unlimited objective. But the phrase might quite as well refer to the necessity of a unit being prepared to employ its full power, even to the exhaustion of its reserves, in order to attain its objective, whether limited or unlimited. If that is the meaning of the phrase, then it not only does not support Captain Hart's argument for the unlimited objective, but it actively opposes his strangely defeatist attitude on the handling of reserves which would apparently require us always to admit defeat rather than to throw our reserves into the battle.

19. We wish that Captain Hart would give us something of his experience on which his views are based. There is at this time a great need that the individual experience of officers of the Great War should be recorded while it is still comparatively fresh in our minds. Yet, while our military periodicals deal fully with the interesting but unimportant vagaries of the late Colonel Hentsch, they ignore the vitally important strata of military history.

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What were the experiences of a certain platoon of Captain Hart's battalion on a given day? How did the men comport themselves before zero? What was the effect, if any, on their morale of the long wait on the forming-up tapes? How did they go "over the top"? How was it that the platoon lost direction? What were the conditions which resulted in the platoon being held up? What efforts were made to get it forward? To what extent did they succeed? How much of the situation was the platoon-commander able to see?

It is for such details as these that the next generation of soldiers will hunger. And unless an effort is made to satisfy them they will hunger in vain. These are the really important aspects of history; but I know nowhere where an attempt is being made to preserve and to classify them.*

Yet the need is great. Many officers will unhesitatingly undertake to criticize the strategy of Ludendorff; comparatively few will offer a confident opinion as to the psychological effect on the infantry soldier of lying down to fire during the attack, or as to the measures necessary to rally troops falling back before an enemy attack. Yet it is on the answers to such elementary questions as these that the whole structure of tactics is based.

20. It is, therefore, to the public interest that Captain Hart should continue the good work of his *National Review* article and that he should make another attempt to explain himself.

But, if he would be convincing, he must abandon altogether the methods of his lectures. He must deny himself the use of catch-words and the easy path of flap-doodle. He must put away his "man-in-the-dark," his "expanding torrent," his "human tank," and his other dummies. He must eliminate his intelligent and invulnerable tadpoles. And in their place he must show us Private Clark, Sepoy Thakur Singh, Corporal Millar, Subadar Bir Bahadur Gurung, Lieut. Jones, Major Pott and Colonel Blunderbore as they are; not as super-men, but as human beings, with all their characteristic limitations. He must exhibit them operating his universal system, not in diagrams, but in the mud, blood and barrages of Flanders, under the sun of the Sahara, on the plains of Iraq, or amid the rocks and nullahs of Waziristan. He must show them fighting with the organization, the armament and the gun-power with which mobilization will actually provide them. Fighting, too, not against a chequer of shaded blobs, but against real and varied enemies.

If he can show us his universal system working smoothly in all these circumstances, we shall acclaim him a benefactor to the Empire. Meanwhile . . . . "*ziyādā hād-i-ādāb*," as they say in India!

* Nowhere, that is to say, except it be in the *Journal* of the R.U.S.I., which has already given us several human documents, and which, in its May issue, publishes an admirable example of what is required in an article by Bt.-Major Hudson, V.C., D.S.O., M.C.

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A CORPS LAUNDRY.

By MAJOR W. HYDE KELLY, D.S.O., R.E.

THE title of this article lacks lustre, but I do not think the subject has been dealt with before in the *R.E. Journal.*

A laundry has become a necessary feature in the administrative services of an army corps, necessary to the cleanliness and health of the troops, and necessary also in the corps area, as any site further towards the rear becomes too far distant for practical purposes. Laundries grew up, as did everything else, from small beginnings. The first bathing establishment where men who had spent three weeks or more without taking off their clothes could be given the luxury of hot water and soap was established in Armentières in November, 1914, where some big brewers' vats were made use of as bath tubs. But this did not solve the problem of bathing more than a fraction of the number of troops, nor did it provide them with fresh clean underclothes in exchange for their old ones. The demand, therefore, for properly organized laundries arose very quickly, and the following account of one which was established at Aire may be of interest.

The place selected was a corner of the old French infantry barracks of the town. The river Lys ran along the south edge of the barracks, furnishing all the water that was required. A troop stable, which had been recently used by the French as a sick horse depôt and had a concreted dipping bath alongside, was taken over for the washing operations ; part of a men's barrack block for the mending, ironing and dispatching stages, and a large wooden stable for drying shed. The daily output to be catered for was 10,000 pieces, five " pieces " constituting the soldier's underclothes. The labour was to be provided by Frenchwomen of the town, but, as Aire at that time was a favourite attraction for the enemy's night-bombers, the inhabitants left the town at dusk and slept in the surrounding villages. Washing was to be done in wooden tubs, of which a good supply was obtainable on the spot from the local breweries. No laundry machines were provided ; everything had to be improvised.

The first step was to ensure a constant supply of hot water. Fortunately, the French had left us an old vertical boiler which blew steam through a 1,000-gallon tank erected on a stage 15 ft. high in the middle of the stable. This was a nucleus which saved a lot of work, but there was no supply of water to feed the tank. A small " Valiant " engine used for fire purposes was procured from an Electrical and Mechanical Company, and this was installed outside

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the stable, with a 3-in. suction pipe led into the river Lys 15 ft. away. This supplied all the water necessary for the preliminary dipping tank, for the hot water tank, and for the cold rinsing tanks. The horse dipping bath was, of course, chosen for the preliminary soaking of the clothes. A wooden partition was wedged across the dip where the sloping entry ended, to prevent clothes from stranding at the shallow end. Disinfectant was poured in, and the dip filled with cold water. The clothes, as they arrived, were turned into this bath, and kept turned over and over by long-handled wooden blades, worked by hand. From this bath, they were carried in barrows to a large rinsing bath, home-made out of 9 in. by 3 in. timber, tongued on the spot, and well white-leaded at the joints, and clamped with iron rods running through each member and screwed up top and bottom. From the rinsing bath, the clothes went to the wash-tubs. There were 100 of these, raised on long wooden benches, about 18 in. above the floor, and fed by 1-in. piping suspended vertically between every alternate pair of tubs, and furnished with short lengths of rubber hose pipes so that four tubs could be filled from each overhead pipe. This pipe system was run direct from the hot water tank on its platform in the middle of the building. Each woman at the tubs had a scrubbing board, and behind them the mangers of the stable were covered over and provided a further scrubbing bench. From the wash-tubs, the clothes went to two more wooden tanks, 8 ft. by 8 ft. by 8 ft. each, and were rinsed in cold water. Thence they were hand-wrung and hung outside on wires (galvanized) stretched across the parade-ground; or, if the weather was bad, the clothes were hung in the wooden stable, which was closed up and fitted with four stoves, with their flue-pipes carried gradually upwards along the shed.

After drying, the clothes went to the mending-room, in the barrack block; next, to the ironing-room, which boasted ironing benches and a useful device for heating irons in tiers round a stove. From the ironing process, the clothes passed into the next room to be made up into bundles, and then they were thrown out of the window into an enclosed wooded "chute" with a turn in it, so that the bundles fell through the window on to the floor of the room below, which was the storing and issuing department, whence lorries carried them off to the various bathing places. The river Lys not only provided the water for the laundry, but it also carried off the foul water from the wash-house floor. This was first filtered through a box containing gravel and clinker, but, as the town was practically uninhabited, the pollution of its river did not alarm the local authorities in any way. The water from the disinfecting bath was pumped separately into the barrack drains.

The work was carried out by the 552nd (Aberdeen) Army Troops Company (T.F.).

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AN OUTLINE OF THE EGYPTIAN AND PALESTINE CAMPAIGNS. 1914—1918.

By MAJOR-GENERAL SIR M. G. E. BOWMAN-MANIFOLD, K.B.E., C.B., C.M.G., D.S.O., *p.s.c.*

(Continued).

CHAPTER VI.

PALESTINE: THE SECOND OFFENSIVE. THE CAPTURE OF BEERSHEBA AND GAZA.—Sir Edmund Allenby's recommendations—Description of the Turkish position—British preparations for the offensive—The Yilderim Army intended to recapture Bagdad—Plan for the capture of Beersheba—Advance of the Desert Mounted Corps and XXth Corps—First attack on Gaza—The Turkish counter-stroke north of Beersheba—The break-through on to the Plain of Philistia—Charge of 5th Mounted Brigade at Huj.

PALESTINE: THE SECOND OFFENSIVE. THE CAPTURE OF BEERSHEBA AND GAZA.

GENERAL SIR EDMUND ALLENBY assumed the command of the Egyptian Expeditionary Force on 28th June, 1917, when the general situation locally was as follows:—

In the Sudan and Western Desert all was clear. The Abyssinians had reaffirmed their friendliness. Siwa had been garrisoned. Only on the north coast we were troubled by enemy submarines lurking and collecting information of our shipping through the canal. Egypt itself was quiet.

The Arabs in the Hedjaz had steadily gained ground and adherents. Medina alone had resisted their attacks; but the Hedjaz railway was continually being interrupted by their action. The Emir Feisal's army was to be moved up the Red Sea coast to Akaba, to be still more on the flank of the Turkish line of communications with Medina.

On the Palestine front there had been a deadlock in May and June. The Turks had greatly reinforced and extended that front since the Second Battle of Gaza, and had dug and wired themselves in; and the British had done the same. In front of Gaza position warfare prevailed. Our right flank was open, but we could not move there for lack of water and transport.

In Mesopotamia, the Turks had set themselves in earnest to retake Bagdad, and the Yilderim Army had been formed. Germany had appointed von Falkenhayn to the chief command, and had provided an Asia Corps and much material for these operations.

Sir Edmund Allenby had been instructed to report on the conditions under which offensive operations against the Turks in Palestine might be undertaken. He very soon went up to that front, and personally reconnoitered the country from south-west of Beersheba to Sheikh Ajlun. He reported that, given a force of seven

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infantry and three mounted divisions, Gaza and Beersheba could be attacked with the prospect of reaching Jerusalem. The chief reinforcements immediately required were :—

Two fully-trained divisions ;
Eleven 18-pdr. and 4·5-in. howitzer batteries ;
Six groups of heavy artillery ;
Three squadrons of R.F.C.

In fulfilment of these demands, the 60th and 10th Divisions were transferred from Salonika ; some heavy artillery from Italy, and most of the remainder from the United Kingdom, and also Indian Cavalry from France.

The Turkish Position, Gaza–Beersheba (*Plates* VI. and VII.).—The country between Gaza and Beersheba constitutes the southern edge of the Plain of Philistia, and may be termed " open " ground of varying character, as it changes from the sea-coast sand dunes of Philistia to the rocky limestone spurs of the Judean Hills.

Further east, after Sheria, the rolling downlands merge into bare sandy hillocks, and rocky outcrops, which rise into rough and arid hills 1,200 ft. to 1,500 ft. high. This ground, east of Wadi Sheria, is difficult for transport and offers no overhead cover. Tel el Khuweilfeh and Towal Abu Jerwal, respectively 12 and 6 miles north of Beersheba, are prominent outlying features of the Hebron range. South and south-west of Beersheba is a lower, but very similar, block of limestone hills, devoid of water, which extends for about eight miles towards the upper Wadi Ghuzzee.

Beersheba itself is about 900 ft. above the sea, and lies in a hollow. The town is dominated by Tel es Saba on the east, Ras Ghanam on the south, and Hill 1070 on the south-west. Six roads converge on Beersheba. Three of these, Jerusalem–Hebron, the Gaza, and the Asluj roads had been roughly metalled, and could be used for motor traffic. The other roads were only well-worn tracks, all passable by horsed vehicles and light cars, but with steep crossings at the big wadis. All this country is drained by three affluents of the Wadi Ghuzzee, viz. :—

Wadi Sheria, which crossed the Turkish line at Hareira ;
Wadi Imleh, which crossed the Beersheba Railway at Irgeig ;
Wadi Saba, which passes through Beersheba itself and comes down from Hebron.

All these *wadis* are torrent beds, with steep-cut sides—5 to 30 ft. high—and stony floors.

Wadi Ghuzzee, under various names, falls south-south-east towards Shellal, after passing through Khalasa, Asluj, Esani and Gamli. Patriarchal springs and wells exist at all those places, and water could be speedily developed with modern appliances.

West of Shellal, the country formed a sandy plateau, falling

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gently to the sea. It was passable, but not easily, by horsed vehicles, and on swept tracks by light Ford vans and motor-cars—but not by motor lorries.

East of Shellal was a broad cultivated plain, famous for its barley, which extended through Karm to Towal el Habari. It afforded fairly good going for all transport, including motor-lorries, and it boasted a few wells.

By July, 1917, Gaza had become a well-armed, equipped, and garrisoned fortress. To prevent its envelopment, the Turks had constructed a chain of strongly entrenched localities extending almost to Beersheba along 30 miles of front. Besides the works immediately covering Beersheba, there were five other systems of redoubts: Kauwukah, Hareira, Baha, Atawineh, Sihan. These works supported each other, except on the extreme left of the Turks, where a gap of about 4½ miles occurred between the Kauwukah and the Beersheba defences.

The Turkish communications in rear were fairly good. The Gaza–Beersheba road connected up these groups, and the country north of it generally was passable for horsed transport. The Wadi Surar Junction–Beersheba railway (3 ft. 6 in. gauge) passed through Sheria and the Tine–Gaza branch was completed to the Wadi Hesi, and was being extended to Army Headquarters and its Reserve Centre at Huj.

The Turkish forces in Southern Palestine consisted of the XXth and XXIInd Corps, with the 3rd Cavalry Division—in all, nine divisions, 25 regiments of infantry and three cavalry regiments—total about 50,000 rifles, 1,500 sabres and 300 guns. These forces at first were under Ahmed Jemal Pasha, G.O.C. IVth Army, with Colonel von Kressenstein as Chief of Staff. But, at the end of October, they were brought under the Yilderim Army Group. Then von Kressenstein became G.O.C. VIIIth Army, with Headquarters at Huleikat, and Fezvi Pasha, G.O.C. VIIth Army, with Headquarters at Hebron, and Jemal was passed on to the line of communication.

The British Position and Preparation.—The British line directly in front of Gaza was not much altered at first after the second battle in April. But, above Tel el Jemmi, the right flank was pushed up to the Wadi Ghuzzee. The British held Shellal for its water; and, when the railway approached Shellal in July, infantry were moved on to the plain near there, and mounted troops went further up to Tel el Fara and Gamli. But the bulk of the depôts and reserves were kept between Rafa and Khan Yunus. The front in July extended for about 22 miles. During the summer numerous reconnaissances were made east of the Wadi Ghuzzee, and the Turks became accustomed to our troops approaching the Wadis Imleh, Sheria and Saba. These reconnaissances had confirmed that the

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weakest part of the Turkish chain of defences was between Kauwukah and Irgeig. There was the gap of 4½ miles between the end of the Hareira defences and the beginning of the Beersheba system.

The following considerations affected the selection of the locality for the main assault :—

(*a*) Gaza itself.—A naturally strong position, was now heavily armed, entrenched and garrisoned. To pass that fortress would involve hewing a way through by sheer strength of artillery. Such operations are unavoidable when no flank is available, but offer no more than local success. If the Turks should elect to retire from Gaza they had as good a position behind the Wadi Hesi, by Deir Seneid.

(*b*) The Atawineh area similarly, if penetrated, offered no substantial advantage.

(*c*) The Hareira–Sheria sector seemed the weak spot. If British troops could reach and overrun it, the whole of the Gaza position would be turned ; and they would be on the flank of the Turks as they fell back and there would be scope for the large British force of mounted troops.

(*d*) Beersheba had abundant water ; but the locality would only be of service as a rendezvous for another bound forward. The place would be an incumbrance if the British were checked there.

(*e*) The conclusion, therefore, was that the main attack ought to be directed against the Turkish left—the defences Sheria–Hareira, but, that it was essential first to seize Beersheba by a surprise, as it was necessary to secure the water, and the space to develop the principal attack.

(*f*) The Turks seemed predisposed to expect that Gaza would still be the objective of the main attack ; and, to encourage this belief to the very end, it was determined also to attack Gaza.

Immediately after his return from reconnoitring the Palestine front, Sir E. Allenby reorganized the command, and moved his G.H.Q. from Cairo to near Rafa. The Eastern Force was abolished ; and the troops east of the canal were formed into the XXth Corps, XXIst Corps, Desert Mounted Corps and Palestine Lines of Communication (see *Appendix* I for fighting strengths). Kantara supplanted Alexandria as the principal base ; quays for ocean steamers were built along the Suez Canal, and immense depôts of ordnance stores, supplies, and remounts grew up there.

The doubling of the military railway, and of the 12-in. pipe-line was accelerated. Large quantities of mechanical transport were assembled at Kantara to go up the line as soon as they could be utilized.

In the immediate front, a great deal of work was put in hand,

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especially in improving the forward communications, and water, and in preparation for heavy artillery reinforcements. Light railways, heavy telegraphs, wire roads, cleared tracks for Ford vans, water cisterns, surf-boats—and much of the latest equipment of trench warfare, such as sound-ranging, balloons, listening sets—all were utilized. Throughout the five months of preparation the trench warfare was actively offensive; and the impression gained ground that Gaza again would be subjected to direct assault.

The change of Commander-in-Chief, and the British preparations in the summer, were duly appreciated by the enemy. It is known now that, in August, the German Staff in Palestine concluded that the British would make another effort to break through, and realized that, unless the Turks were very heavily reinforced, the attack would probably succeed. They wished to shorten their line by withdrawing from Beersheba; but Constantinople would neither permit that, nor allow them the troops they requested.

Turkish pride and prestige had been deeply wounded by the loss of Bagdad. The plan to retake it had the backing of Berlin. The Asia Corps was on its way to Mesopotamia. To the appeals of Palestine, the reply was:—

> "Every man sent to Sinai decreases the chance of success in retaking Bagdad."

To this the Palestine Command urged:—

> "If the Sinai front is broken, Palestine and Syria will fall into the enemy's hands; and not only will Bagdad not be retaken, but the armies in Mesopotamia will be caught with the British across their lines of communications at Aleppo."

Not until mid-October did this argument prevail, and then it was too late. Von Falkenhayn was in time to supersede Jemal Pasha; and his Yilderim troops, diverted from Mesopotamia, were on their way to Palestine when Sir Edmund Allenby's force captured Beersheba on 31st October.

The general idea of the British operations was to deliver the main blow, in overwhelming force, against the left of the enemy's principal line of defences at Hareira–Sheria. The infantry would then roll up the Turkish line, while the mounted Corps pressed through into Philistia on the enemy's communications. The first step must be the capture of Beersheba; and, to confuse the enemy, Gaza itself was to be subjected to prolonged intensive bombardment, and attacked simultaneously, but with limited objects in view.

Beersheba lay 18 miles from Shellal. The country between was totally devoid of food or forage. The road tracks could not be relied on at first for motor transport. Water was scarce. It was necessary, therefore, to provide special transport to assure supplies and water for the troops operating against Beersheba. It was

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decided to carry the 4 ft. 8½ in. gauge railway over the Wadi Ghuzzee at Shellal on a trestle-bridge, to strip the XXIst Corps units in front of Gaza of most of their divisional transport, and to build out a pipe-line from the Shellal reservoirs to the concentration area at Karm. By this means the XXth Corps and Desert Mounted Corps were given sufficient transport to enable them to move out 20 miles from railhead. About 30,000 camels were utilized in this task.

The plan for the capture of Beersheba was to envelop the place. Two mounted divisions were to attack from north-east, east, and south-east, and two infantry divisions simultaneously were to assault the works on the west, and south-west, while a third infantry division covered the left of the main infantry attack. The mounted troops had to make a circuit of 50 miles from Gamli, through Esani, Khalasa, Asluj to Kasim Zana.

As soon as Beersheba was seized, then Gaza was to be attacked with naval assistance, and two very important localities occupied, while our Beersheba forces were preparing for their next stage—the main attack on Hareira. The Turk was to be kept fully occupied, and yet uncertain as to where the main blow would fall.

Originally, it was expected to deliver the attack near the end of September, but, in waiting for reinforcements, the operations were postponed five or six weeks. Force Order No. 54 was issued on 22nd October, and Zero day was fixed for the 31st.

Paras. 5 and 6 of this Operation Order were as follows:—

"5 (*a*) The XXth Corps will move into position during the night Z–I/Zero, so as to attack the enemy at Beersheba on Zero day south of the wadi with two divisions, while covering his flank, and the construction of the railway east of Shellal, with one division on the high ground overlooking Wadis el Suffi and Hannafish. The objective of the Desert Mounted Corps will be the enemy's defences from the south-east to the north-east of Beersheba, and the town of Beersheba itself."

"6. The G.O.C. Desert Mounted Corps will endeavour to turn the enemy's left with a view to breaking down his resistance at Beersheba as quickly as possible. With this in view, the main weight of his force will be directed against Beersheba from the east and north-east. As soon as the enemy's resistance shows signs of weakening, G.O.C. Desert Mounted Corps will be prepared to act with the utmost vigour against his retreating troops so as to prevent their escape, or at least drive them well beyond the high ground immediately overlooking the town from the north. He will also be prepared to push troops rapidly into Beersheba, in order to protect from damage any wells and plant connected with the water supply not damaged by the enemy before Beersheba is entered. Special instructions will be issued to G.O.C. Desert Mounted

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Corps, and a copy of these instructions will be forwarded for information to G.O.C. XXth Corps."

Special instructions were issued to G.O.C., Desert Mounted Corps, in which he was informed :—

(*i*) The main attack of the XXth Corps could not be launched earlier than between 1000 and 1100 on Zero day.

(*ii*) The mounted divisions must be east of Beersheba early enough to attack it before the enemy should realize the infantry attack of the XXth Corps.

(*iii*) Men and horses were to be kept as fresh as possible for the second, and principal, stage of their operations, in which their rôle would be to pass round the enemy's left and establish the Corps about Tel el Nejile–Wadi Hesi.

Special instructions to the XXth Corps dealt mainly with the action to be taken if the enemy should evacuate Beersheba before we could attack.

The measures taken to mislead the enemy were very carefully elaborated. It must be remembered that the bulk of the troops out of the trench line were kept opposite Gaza, in well-marked camps between Tel el Jemmi–Deir el Belah, and Rafa. In June, as the force spread out towards Shellal, the detachments on the Wadi Ghuzzee had formed similar camps to which the Turkish airmen were well accustomed. The Desert Mounted Corps always had a division in rest on the coast, near Khan Yunus. When the assembly marches began, in the last week of October, all moves took place at night. The brigades departing always left tents standing, and stepped up to an existing camping ground. Camps which were finally vacated were kept going, and arrangements were made to water horses and to create dust at the usual hours and in the usual places. Thus, the enemy's airmen—who got over only at a great height—saw merely the camps to which they were accustomed and no marked changes in them.

The French contingent had their camps and stores at Khan Yunus. Great camel lines existed near Deir el Belah. Extensive light railways had been built, primarily for ammunition supply, conveniently in front of Gaza. A dummy main-line station was constructed at the Wadi Ghuzzee crossing, near the Belah–Gaza road. The enemy was also misled by our indiscreet use of wireless—doctored messages in indifferent cipher—and by other information which he prized, but which was not as good as it seemed.

Finally, Gaza was subjected to eight days' continuous bombardment, as had never been before in all Asia. The evidence to the enemy that Gaza was the enemy's main objective was reasonably conclusive, and when the move on Beersheba became obvious, he considered it to be merely a bluff.

Capture of Beersheba.—The steady bombardment of Gaza com-

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menced on 26th October, when the troops began to take post for the attack on Beersheba. On the evening of 30th October, the XXth Corps and Desert Mounted Corps were concentrated ready for the night march to their position of deployment. There was a full moon, and the weather was sultry.

The approach movements of the three divisions now with the XXth Corps for this concentration were very carefully screened.

First, an outpost line of the 53rd Division was pushed out on the left, to the north-west of Beersheba.

On the right of the 53rd Division, the Desert Mounted Corps furnished a screen about midway between the Wadi Ghuzzee and Beersheba.

Then, on 29th October, the XXth Corps Cavalry Regiment had replaced the Australians; while that night (29th–30th October) the 60th and 74th Divisions, in brigade groups, were moving across the broken ground in the triangle, Esani–Gamli–Beersheba, and lying up by day in the *wadis*.

These divisions were given three lines to work to:—A line for deployment, the enemy's trench-line, and the intended outpost-line to be occupied after the assault, and beyond which units were forbidden to pursue. It was a complex manœuvre to move out three divisions like this by night so far, and get them deployed as required without alarming the enemy.

The 74th and 60th Divisions were allotted the hostile works between the Khalasa road and the Wadi Saba; and part of the 53rd Division further north covered the left of the attack. The right of the 60th Division was covered by the 7th Mounted Brigade.

The first step was to seize Hill 1070, in order to enable the guns to be brought up close enough for wire-cutting in front of the inner defences. The 60th Division took Hill 1070 by 0845 hours. Wire-cutting then proceeded, the main assault was delivered at 1215 hours and by 1300 hours the works between the Khalasa road and Wadi Saba were taken. The defences north of that road took longer to secure, but were captured by 1930 hours and the road into Beersheba from the west was then clear. The only troops of the XXth Corps to go that night into Beersheba were part of the 521st Field Co., R.E., sent in to develop the water supply.

The Desert Mounted Corps had a difficult march; they used two roads—very rough going—and covered from 25 to 35 miles during the night, and commenced their attack to time. Then they met much opposition, and the ground east of the town favoured the defence, being almost flat and commanded by high ground on the north-east and south-east, and flanked by Tel es Saba. Progress was slow until about 1830 hours, when the 4th Australian Light Horse Brigade (Brig.-General Grant) extended, and galloped over two lines of Turks in trenches, and entered Beersheba

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Two regiments rode in this attack, which was delivered in three lines, each of two squadrons, and supported by one section of machine-guns. One regiment was in reserve covering the left rear. The brigade captured 1100 prisoners and 10 guns. They lost 31 killed and 33 wounded. They found the water supply intact; although the wells had been prepared for demolition, the Turks had neglected to fire the charge. The whole operation was a complete success. The Turks were surprised, they were given no time to reinforce, and a very strong position was taken with relatively small loss.

The First Attack on Gaza.—The XXth Corps now required a short time to assemble and deploy for the attack on the Sheria–Hareira defences. Meanwhile, the XXIst Corps was directed to capture the line Umbrella Hill–Sheikh Hasan, a frontage of about 6,000 yards to a maximum depth of 3,000 yards. It was expected that this attack would draw Turkish reserves towards Gaza.

This operation was executed in two stages. At 2300 hours on 1st November, Umbrella Hill was rushed. The next stage was fixed for four hours later, and for two hours the Turks kept up a heavy bombardment, which closed down just in time for the British assault on Sheikh Hasan to proceed.

The preliminary bombardment by the XXIst Corps had been so destructive that in one division the Turks lost a third of their troops, and were obliged to replace that division by another from the General Reserve. So, the blow on the left also achieved its purpose: it had seriously threatened the whole Gaza sector, it had compelled the Turks to bring reserves into Gaza, and had convinced them that Gaza was the objective of the main attack.

Very sultry weather now set in, and hampered the preparations of the troops about Beersheba, so that an additional day was required to complete them.

The Turkish Counter-stroke north of Beersheba.—While the XXth Corps and the Desert Mounted Corps were making ready, on 1st and 2nd November, the 53rd Division moved out about seven miles north of Beersheba. The 10th Division (General Longley) took post at Irgeig. The Australian Mounted Division relieved the Yeomanry Division in General Reserve.

On 3rd November, the 53rd Division moved on towards Khuweilfeh over difficult country. General Mott now met with strong opposition, and on 4th and 5th November he was counter-attacked. The Turks brought up eight battalions and three cavalry regiments, and repeatedly tried to throw the 53rd Division back on Beersheba, without success.

This attack has been judged to have been a bold effort to induce us to alter our plans, and to attract a large force into the hill country up the Hebron road.

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Sir Edmund Allenby's comment was :—

> " Had the enemy succeeded in drawing considerable forces against him in that area, the result might easily have been an indecisive fight, ... and my own main striking force would probably have been made too weak effectively to break the enemy's centre in the neighbourhood of Sheria–Hareira. However, the enemy's action was not allowed to make any essential modification to the original plan."

The Break-Through on to the Plain of Philistia.—The attack on the Kauwukah and Rushidi works of the Hareira sector of defences was ordered for dawn on 6th November, and, it was intended to secure Sheria and its water by nightfall. The 53rd Division and Imperial Camel Corps continued to be heavily engaged all day on the 6th November holding off the last of von Kressenstein's counter-stroke at Khuweilfeh.

The 10th and 60th Divisions, supported by the 74th Division (General Girdwood), successfully stormed the Hareira lines ; while the Desert Mounted Corps, again rejoined by the Australian Mounted Division, stood by to push into the gap made by the infantry. At 1600 hours the Desert Mounted Corps started northwards, and later, the 60th Division (Major-General Shea) was directed to follow it up into Sheria, which was occupied that evening. Still the enemy was given no respite. The second assault on Gaza was ordered for this night (6th–7th November).

Outpost and Middlesex Hill on our right were to be taken at 2330 hours, and Turtle Hill on the left at 0500 hours. Observe again the successive blows right and left. But the Turk had had enough. That night he withdrew. Only the Atawineh works were still held ; Gaza was empty and some of the XXIst Corps moved through it on 7th November.

It was now the turn of the XXIst Corps to take the road. The 52nd Division (General Hill), preceded by the Imperial Service Cavalry Brigade (Brig.-General Harbord), advanced by the coast, drove in the Turkish rearguards, and reached Deir Seneid on the evening of the 8th November. The 75th Division (Major-General Palin) stayed to deal with the Atawineh Redoubts, and the 54th Division (Major-General Hare) was left to clear up Gaza itself.

The Desert Mounted Corps was strongly opposed, and made little progress without infantry support. The Cavalry were in difficulties for water, which was in deep wells and its distribution slow. On the night 7th–8th November, the Turks managed to extricate the garrison of Atawineh, before the gap could be closed.

On the 8th November the Australian and New Zealand Mounted Division secured a good water supply at Jemmameh, after obstinate fighting. The Australian Mounted Division, closely supported

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by the 60th Division, marched towards Huj ; and a large amount of Turkish artillery was captured. But, in the afternoon, the 60th Division was checked in open country, about a mile west of Huj, by a strongly-posted Turkish rearguard of about two battalions with well-concealed machine-guns and artillery. Part of the 5th Mounted Brigade were close by, and the G.O.C., 60th Division, called on these troops to charge and clear the way. The 1/1st Warwick Yeomanry (Lieut.-Colonel Cheape), and part of 1/1st Worcester Yeomanry—altogether, ten troops—about 170 sabres—were moved rapidly to the right flank, under shelter of a fold in the ground, unseen by the enemy, to within 800 yards of the flank of the hostile batteries. The Yeomanry then charged home, in three lines ; and, in spite of desperate resistance, cut down the gunners and dispersed the infantry. They captured a field battery, a mountain battery, and four machine-guns. The Yeomanry lost 75 all ranks, killed and wounded, including Lieut.-Colonel Cheape, killed. This gallant action provides a fine example of the cavalry charge ; it was sudden, rapid and opportune ; use was made of the ground, surprise was achieved, and the way was opened for the infantry.

The Turkish VIIIth Army now was in full retreat, northwards. The Royal Flying Corps bombers did much execution against the Turkish columns, crowded on the two roads from Gaza. All reports showed that the enemy was greatly disorganized, and persistent pursuit would complete his rout.

Comments.—This phase of the campaign, leading to the capture of Beersheba, is remarkable in several respects.

First, for the most careful and long preparation devoted to it — July to November—during which time much was done in building railways, organizing transport, developing water, and massing the artillery and other reinforcements.

Next, for the secrecy with which the real plan was shrouded, and preserved from the enemy. And, without this secrecy, the operations would have had little hope of success.

Lastly, these operations are remarkable in that they dealt simultaneously with both stationary and open warfare, and brought in the artillery co-operation of the Royal and Allied navies.

There was Gaza, a stabilized front, and the scene of an extensive bombardment, and of brilliant local operations of trench warfare. And 35 miles away, was the rather exposed outpost at Beersheba, secure, apparently, behind a wide belt of arid country, but still open to surprise and seizure by determined mobile troops. It will be noticed that the mounted divisions were used away on the right, in the dry desert, where the ground was suitable for a great enveloping movement.

In the next phase, these same mounted divisions were brought across to the coast to fight in the fertile plain of Philistia.

(*To be continued.*)

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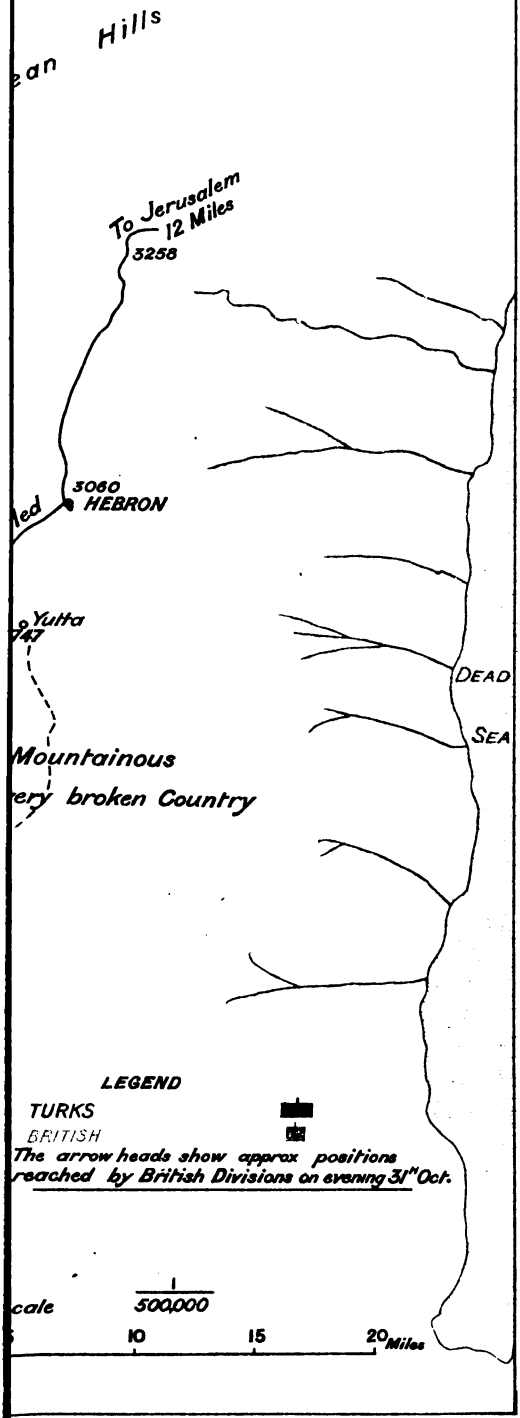
PLATE No VI.



Ordnance Survey, January 1931.

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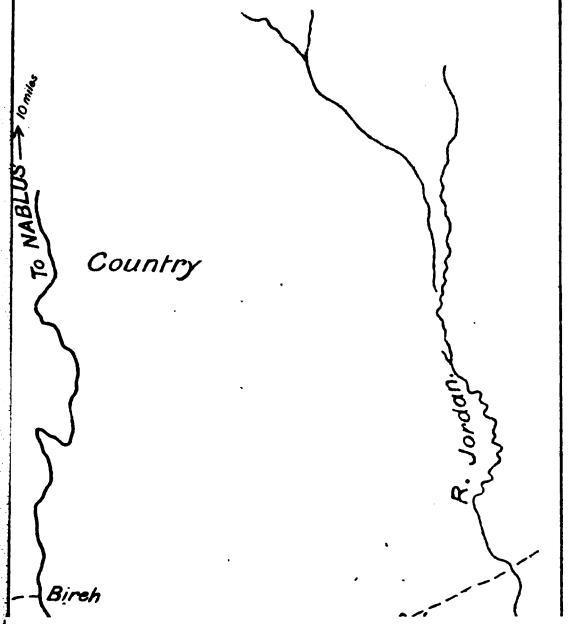
MAP Nº 330

COND OFFENSIVE

PLATE Nº VII



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APPENDIX I.

EGYPTIAN EXPEDITIONARY FORCE.

FIGHTING STRENGTH—WEEK ENDING 20TH OCTOBER, 1917.*

	Officers.	*O.R.*
I. *Desert Mounted Corps.*		
Anzac Mounted Division	212	4981
Australian Mounted Division	202	4929
Yeomanry Mounted Division	197	4739
7th Mounted Brigade	54	1118
Imperial Camel Corps Brigade	80	2168
Total	745	17935
II. XX*th Corps.*		
10th Division	399	9252
53rd Division	359	11855
60th Division	346	11683
74th Division	331	11381
Total	1435	44171
III. XXI*st Corps.*		
52nd Division	349	10675
54th Division	340	11147
75th Division	295	9227
Composite Force	170	3710
Total	1154	34759
Grand Total	100,189	

* Infantry and mounted regiments only.

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REVIEWS.

MANUAL OF ANTI-AIRCRAFT DEFENCE.

By MAJOR A. E. KING, R.G.A.

General Considerations.—The means employed consist of :—

Machine-guns in aeroplanes ; anti-aircraft guns on the ground ; small arms on the ground. (NOTE.—Units of other arms are responsible for their own defence against aircraft below 3,000 ft.) ; searchlights (as an adjunct to the above three at night) ; sound locators (ditto) ; balloons and aerial obstacles ; alterations of landscapes and employment of false areas ; obscuration of lights at night in factories, etc. ; smoke screens.

Stress is laid on the speed at which an enemy moves, and the consequent necessity of quick communication and rapidity of fire, *e.g.*, a plane flying directly over a gun, at 15,000 ft. at 100 miles per hour, would only be in range for about four minutes by *day*. (This is comparable to the time available in the case of a torpedo-boat at 35 knots being picked up in a beam at 2,000 yards by *night*, allowing for the return journey.) Hence advanced observers with sound locators must be used to give timely notice of the enemy, so that civilians, as well as the guns and lights can be warned. Operation orders will be standing orders as in the case of anti-torpedo-boat work.

Organization and Administration.—The Anti-Aircraft Brigade will consist of :—

R.A.F.	...	... 1 or more squadrons.
R.A. ...	...	... 2 Brigades of 16 to 40 guns.
R.E. ...	...	... 1 Battalion of 96 to 144 searchlights and proportion of locators.
Signal Corps	...	... 1 Section.

The O.C., Anti-Aircraft Defences, will be directly under the G.O.C.-in-C., and will issue the necessary warnings to civilians as to obscuration of lights, etc. Normally there will be one Anti-Aircraft Defence Brigade to two Divisions of the line.

Anti-Aircraft Artillery.—Light mobile guns will be used in front areas, and light and heavy fixed guns in back areas. Telephones are most important, especially when co-operating with other means of defence.

Gunnery.—The gun corrections necessary to allow for travel of target, are given in terms of vertical and horizontal deflection. To estimate these, it is assumed that the target will fly in a straight line and at constant speed during the time of flight of the shell (as is usual in gunnery). It is obviously essential to make these two assumptions, and equally obvious that, owing to the great speed of the target, they will often be sufficiently

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false to make the round miss the target. Therein lies the great difficulty of Anti-Aircraft gunnery.

A point can be fixed in space by its height, angle of sight and bearing. The height of an aeroplane is fairly constant compared to its range, which alters at a great rate. It is, therefore, found convenient to set the gun-sights for height. The angle of sight and bearing are automatically found by laying the gun. The additional information required to hit the target is the fuze setting, tangent elevation, and the correction for travel in the vertical, and in the horizontal planes.

For a given range, the fuze setting and tangent elevation vary considerably for different heights. For instance, the correct fuze for a certain horizontal range would burst nearly 2,000 ft. above a vertical target at the same range. But it is easy to make a graph of the loci of a given fuze setting at different heights, and, by graduating the sights in fuze settings, instead of yards, the necessity of ordering tangent elevation is obviated.

Such a graph is mounted vertically as a gun sight, and corresponds to the tangent sight on an ordinary gun. It is read by a pointer which is first set for height. Thus the height and fuze are ordered, instead of the range and fuze in a field-gun.

The *height* is found and constantly checked by a "height-finder." The "single station" height-finder is a modified Barr & Stroud range-finder, which also measures the angle of sight. It is so geared that when coincidence is obtained, the height, instead of the range, is registered. Other height-finders depend on the principle that when two planes are mounted on horizontal axes parallel to each other at a known distance apart, the height of their intersection above their axes can be calculated. Observers rotate the planes until each is aligned on the target. The angle which each plane then makes with the horizontal normal to its axis is transmitted to a central station where the height is estimated. In some instruments the height is automatically shown as the planes are rotated.

The *fuze setting* (*i.e.*, the range, fuze and T.E.) is found by a "height fuze indicator." This instrument has a graph similar to that mentioned above and mounted vertically. The index of the instrument is adjustable for height, and is moved by a telescopic sight which is kept laid on the target. The vertical angle between the telescope and the bar on which the index slides, is set according to the predicted angular movement of the target during the time of flight, plus the "lost time" (*i.e.*, the time between the observation being made, and the gun being fired). The instrument then gives the correct fuze setting (which includes the T.E. and vertical deflection) to burst the shell at the spot where the target will be when the shell reaches it. In fact, the instrument functions exactly like a position finder.

The *correction to allow for travel* is found by a "Broq." This instrument consists of a telescope moved by two handles; one in the vertical, and one in the horizontal plane. The handles are each geared to a dynamo, and the instrument is so constructed that the E.M.F. generated by the dynamos are proportional to the angular speed of the target. The E.M.F. is adjusted by resistance to compensate for the time of flight,

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and the predicted angular movements are then read on two instruments on the principle of volt-meters.

The sequence of events is thus :—

(*a*) The height is found by the height-finder ;
(*b*) The height is set on the height fuze indicator and on the gun-sights ;
(*c*) The fuze is obtained from the height fuze indicator ;
(*d*) The Broq is set to the fuze obtained from (*c*) and then gives the prediction ;
(*e*) The prediction obtained from (*d*) is set on the height fuze indicator ;
(*f*) The operations (*c*), (*d*) and (*e*) are repeated until a balance is obtained ;
(*g*) The predicted fuze is given to the gun and to the loading numbers, and horizontal and vertical deflections are given to the gun.

In some cases the Broq or the gun itself can be used as a height fuze indicator.

Methods of Fire.—The system of engaging an enemy is to fire a group of rounds with the same fuze-setting so as to form a zone through which the enemy must pass. Possibly, with a new equipment, or with heavier guns, it will be advisable to change the fuze for each round.

Observation of fire and the consequent correction of bursts, is extremely difficult. It will rarely be possible to judge from the guns whether bursts are short or over. Aeroplanes fitted with wireless telegraphy and flying parallel to the enemy at the same height, are likely to give valuable information, but, in many cases, reliance must be placed on the height-finding instruments, rather than on observation of bursts.

Firing at an Unseen Target.—Barrage-fire is employed against aeroplanes behind clouds, etc. Its principal value is its moral effect, as small high-explosive shells have little forward effect, and only a radial effect of about 20 yds. Also it is difficult to predict the course of the target.

Sound locators placed about five miles ahead of the gun positions can determine the height, speed and course of a target sufficiently accurately and quickly to enable the guns to put up a barrage which will scare the enemy away. The sound locator is described later.

Bombing by Aeroplanes.—The following table gives some idea of the difficulty of hitting a small target from an aeroplane. The table shows the horizontal distance at which a bomb must be dropped from an aeroplane travelling at 100 miles per hour, in order to allow for the horizontal travel of the bomb after release :—

Height (feet).	*Horizontal Distance (yards).*
2,000	... 600
4,000	... 700
6,000	... 800
8,000	... 900
10,000	... 950
12,000	... 1,000

Searchlights.—These are used to point out targets to our aeroplanes or guns, and to help them in the subsequent engagement. Two good

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beams on a target are enough for our aeroplanes, but a gun prefers to have three beams. Searchlights on the boundary of a lighted area expose their beams at as low an elevation as is possible and useful, so as to give an early indication of the target. Not more than three beams are exposed on one target so as not to cause confusion. Defending aircraft are responsible for giving signals to show that they are friendly. Our aeroplanes often find it difficult to pick up an enemy in daylight, and it is almost impossible to do so at night, or to maintain contact without searchlights.

The equipment of searchlights, consisting of generator, cables and projector, must be capable of rapid transit to, and action in, a new position. The lorry used has an engine directly coupled to a dynamo (after the Tillings-Stevens system), which can be used either to drive the lorry by a motor, or to run the light.

The projector is mounted to give all-round traverse and 90 degrees elevation. It is controlled in the horizontal plane by a control-arm, about 15 ft. long. If the arm is rotated, the beam moves vertically. The operator of the control-arm has a head and breast set to the sighting number on the sound locator, from whom he obtains instructions when picking up an invisible aeroplane, as to the direction in which the aeroplane can be heard. When the operator of the control-arm sees the target, he takes over control of the beam, and it is found that 15 ft. is far enough away from the beam to prevent him being blinded by the light.

Sound Locators.—Sound travels by means of waves varying in length. Those audible to the human ear vary from $\frac{1}{3}$in. to 70 ft. Sounds from aircraft vary from 10 to 15 ft. The ear is sensible to phase difference, *i.e.*, can detect whether the top or the bottom of a wave is hitting it. When trying to find an audible object, the head is instinctively turned until both ears are in phase, and the object is then in front.

The principle of the sound locator is that the sound is collected in four trumpets fixed parallel to each other in a frame. They are arranged in pairs, and each pair is connected by tubing to the ears of a listener. One listener can move the locator horizontally, and the other vertically. The listeners move the locator until the sound is at a maximum, and an observer then endeavours to pick up the target by looking over the sights fixed parallel to the trumpets.

At night the observer directs a searchlight to move so that the beam is in prolongation of his sights. Corrections are made for the travel of the target during the time the sound takes to reach the locator. Locators can be used up to six miles. When used in advanced positions for intelligence, a fair estimate of the course of the target can be deduced from the angles of elevation and trainings given by the locator. When observations from two locators are available, the height, course and speed can be worked out.

Passive Defence (Aerial Obstacles).—The mere fact of stationary balloons being up has a moral effect on aircraft pilots as they cannot see the wire cable. In the "Apron" system, sets of three balloons are linked together by a horizontal cable carrying streamers weighted at the ends.

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Obscuration of lights.—Small towns can be completely hidden at night by obscuring the lights. Large towns cannot be concealed in this way, and it is a question whether the great drawback of darkness is compensated for by the advantage of partial concealment. Signal lights on railways and dimmed lights on road vehicles are invisible, but the glare from the furnace shows up a train. Division of the country into areas is necessary to prevent the wholesale stoppage of work, etc.

Smoke Screens.—These, on a small scale, *e.g.*, for a small factory, merely draw attention to an area worth bombing, and on a large scale are difficult to organize, and are liable to interfere with Anti-aircraft lights, guns, etc.

NOTES ON SPORTING RIFLES.

By COLONEL H. V. BIGGS, D.S.O. (late R.E.).

IN case they may not have heard of it, I would like to call the attention of any brother officers interested in sporting rifles to a most useful little book, called *Notes on Sporting Rifles for use in India and elsewhere*, by Major Gerald Burrard, D.S.O., late R.F.A., price 4/6, published by Edward Arnold.

It first appeared several years ago as a series of articles in the *Field*, but has since been published in book form. It appears to me the most practical one that has been published since *The Modern Sportsman's Gun and Rifle* of the early 'eighties. It gives most useful tables of practically all modern rifles, showing charge of explosive, weight of bullet, with M.V. and energies at sporting ranges; also, separately, tables of trajectories. In addition, it is full of most useful notes and tips about big game shooting generally, sights and sighting, cleaning and care of rifles, etc., as well as much information that is not ordinarily known to those who have not made a special study of rifles. Anyone about to buy a rifle would, I am sure, do well to first obtain this book and study it carefully.

Major Burrard deprecates a rifle under about 8 lbs. weight and recommends barrels of 26 in. to 28 in. length. This is undoubtedly correct generally and for one's main battery. At the same time, one is often disinclined to carry a heavy rifle in great heat, or towards the end of a long day, and I found that I lost so many shots from not always having a rifle in my hand that I finally got a light magazine rifle of about 7¼ lbs. weight with only about 22-in. barrel, which I always carried myself, generally over one shoulder in the way Major Burrard advocates, and found this a great advantage. Barrels are apt to catch when traversing dense jungle unless they are very short, especially when carried over the shoulder as one must do on steep ground where the use of the hands is necessary for climbing.

The method he recommends of having the distance for which a rifle is sighted dependent upon its trajectory, instead of the arbitrary hundred yards, is one I have practised for some 30 years or more, and had many disputes with gunmakers about. I, however, always took 2 in., instead of his 2½ in., as the maximum height of bullet above the line of sight.

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He strongly recommends black powder express rifles for jungle-shooting, for those who cannot afford expensive H.V. rifles. They are certainly excellent for this, and I found them—with heavy bullets—kill more instantaneously than H.V. rifles of greater power. I think he, however, to some extent underestimates the disadvantages of black powder. I have shot charging game on foot at close range with it and for a second or two have not known what had happened; whether the beast was stopped or was coming on. Often I have fired at animals, and when the smoke cleared there was nothing to be seen; and, except for the sound of the striking bullet, one did not know whether the animal was hit or not, nor anything about its whereabouts; whether it had dropped or gone on, or was lying in wait. Of course, if there is any breeze, the smoke does not matter, it is blown away at once. With smokeless powder one can almost see the bullet hit, and knows exactly what the animal has done.

Another disadvantage of black powder rifles for those who cannot afford more than one weapon is that they are generally unsuitable for hill shooting, as most of them shoot low at high altitudes; the amount varying with the altitude and differing with almost every rifle. A D.B. ·500 Express that I had, firing 6 drs. of powder and a 480-grain bullet, with 26-in. barrels, shot 10 in. low at 100-yds. range at 7,000-ft. altitude. Another ·500 Express, of slightly different load and with a lighter bullet carefully tested with mine, shot 18 in. low under the same conditions. The latter would, quite possibly, shoot 3 ft. low at 14,000 ft. altitude or even more. I well remember the tales brought back from Kashmir in the early 'eighties of the extreme difficulty of judging distance in the hills; some even returning empty-handed in spite of numerous apparently easy shots. It may doubtless have been partly due to the difficulty of judging distance in the hills, but, I am sure, it was mostly due to the different shooting of the old Express rifles at different altitudes, the amount varying as one moved up or down a hillside. The old Service Martini-Henry rifle, however, though firing black powder, did not shoot low at high altitudes, but slightly high, practically in accordance with theory—due to the more rarified air giving less resistance, and therefore a flatter trajectory. I have not known any H.V. smokeless powder rifle do otherwise than shoot slightly high at high altitudes, more or less in accordance with theory. Those I tested shot ¾ in. to 1½ in. high at 100 yds. range at 8,000 ft. altitude. The only reason I can assign for this behaviour of the Express rifles is, having, as they had, as a rule, light bullets with comparatively short barrels and very heavy powder charges, that the lessened resistance in the barrel of the air at high altitudes to the passage of the bullet was insufficient to develop the full force of the powder and that some of it was probably blown out unburnt. The fact that certain Expresses, such as Henry's, which had shallowing grooves that would give resistance right up the barrel, did not shoot low at high altitudes, would lend support to this theory.

My experience of down-hill shooting does not accord with that of Major Burrard, *viz.*, that the high shooting is due to the difficulty of craning one's neck sufficiently; but I may be wrong. I nearly always

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had two completely independent sets of sights on my rifles. One set the open V (almost a straight line) with a fine bead foresight on a rather high block; and, secondly, a Lyman peep-hole backsight with a Beach combination foresight, but with the knife-edge removed and the pivot distance increased so that, when turned down, it lay below the top of the block of the bead foresight; and when turned up, stood clear above the bead. With a rifle with these sights I put up two targets at the same distance, but one on a level and the other at a steep downward slope. I then fired alternate shots at each target with the open sights, using an improvised gunmaker's rest. I have not the notes of this test, but I know that the result showed that, at the down-hill target, the centre of the group was the equivalent of at least 12 in. high at 100 yds., compared with the horizontal target. I think it was a little over 12 in. I then substituted other targets and repeated the test with the peep-hole sights and found that there was no appreciable difference in height between the two groups.

Major Burrard rightly condemns the ordinary Express hollow-nosed bullet generally used with black powder rifles. If these are cut down longitudinally, it will generally be found that there is only a little over $\frac{1}{8}$ in. thickness of lead at sides and base. If one of these bullets strikes an animal in a soft place—like between the ribs behind the shoulder—it will probably prove deadly and drop the animal in its tracks. If, however, it strikes a hard part—like the shoulder muscles—it flies to pieces just under the skin, making a purely superficial wound, only about 2 in. deep. A long, heavy bullet, with a small hollow only extending about half-way down and with a solid, heavy base is, however, quite a different matter. I used bullets like this, cast from melted-down Martini-Henry bullets, of 480 grs. weight, from a ·500 Magnum Express, and it was the most deadly rifle I ever had. Any at all well-placed bullet usually dropped an animal in its tracks, and even badly-placed bullets seemed to have a paralysing effect. With tigers, I, on two occasions, broke the opposite shoulder with it. For H.V. smokeless powder rifles the Westley-Richards capped bullet was quite the best of all that I tried.

The book does not mention a rather curious fact occasionally met with and referred to on pages 362–3 of *The Modern Sportsman's Gun and Rifle, viz.*, that some rifles with the same sight, fired on a level range, shoot higher at 150 yds. than at 100 yds. I came across two rifles that did this, one of which I owned. In both cases they were short-barrelled weapons, almost carbines, with the backsight rather far forward, so that the sights were comparatively rather close together. As mentioned before, I had two sets of sights on most of my rifles, and had on this one. I therefore carefully tested it; first with the open sights with a gunmaker's rest at 50 yds., 100 yds. and 150 yds., taking the centres of groups. The 100-yds. centre was lower than the 50-yds. centre, but slightly less than it should have been by theory; but the 150-yds. centre was $\frac{3}{4}$ in. to 1 in. higher than at 100 yds. I then repeated the test on the same range in exactly the same way with the peep-hole sights and found that the centres in each case dropped regularly with each longer range, practically in accordance with the theoretical trajec-

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tory. It is, therefore, difficult to explain this result with the open sights, unless it may be due to some different focus of eye at different distances, with sights rather close together. It is a great advantage when this happens, as it practically does away with judging distance at ordinary sporting ranges.

As recommended by Major Burrard, it is always best to buy a first-class rifle, either new or second-hand. I believe that it will be found that the eventual cost of doing this—that is, the difference between purchase price and the price when subsequently sold—will not very much exceed that for an inferior weapon. A first-class rifle by a well-known maker, if taken care of, will generally fetch a fair price when it comes to be sold. This certainly used to be the case in India. On the other hand, an inferior weapon will fetch very little.

The following results of experiments with the sun in different positions may be useful to remember when sighting or testing a rifle for 100-yds. range.

WITH OPEN SIGHTS.

Sun on left front makes one shoot about 2 in. right and 1 in. high.
" " right " " " " " 2 in. left " 1 in. "
" " left rear " " " " 2 in. right " 1 in. low.
" " right " " " " " 2 in. left " 1 in. "

Shading the sights makes one shoot about 1 in. high.

It is not, however, known if the above results would be affected by giving a reverse slope, that is, towards the breech, to all parts of both sights, so as to prevent any light being reflected to the eye. In that case it is quite possible that the position of the sun might not affect the shooting.

WITH PEEP-HOLE SIGHTS.

The alignment is not so much affected, but the sun in rear makes one shoot about 2 in. to 2½ in. higher than if in front. Shading the sights makes one shoot about 1½ in. higher than if unshaded.

H.V.B.

NOTICES OF MAGAZINES.

MILITÄR WOCHENBLATT.

No. 47.—A review by General von Kuhl of Field-Marshal Conrad von Hötzendorf's Memoirs (First Volume from 1906–1909) appears. He commences by an appreciation of the dangers which threatened Austria-Hungary at the time of his appointment as Chief of the General Staff in 1906—dangers due no less on account of her mixed population than to the rivalries and aspirations of her neighbours. Conrad, he tells us, lacked no courage in facing them. Any conciliating weakness towards internal Nationalist movements directed against the unity of the empire he held to be wrong. He did not consider that he could escape the external dangers which threatened from Serbia, Italy and Russia by a " wait and see " policy. Military action alone could, in his opinion, relieve the State from this pressure. Von Kuhl declares that Conrad continually emphasized this point of view with the Foreign

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Minister and also with the Emperor Franz Josef, and urged upon them the necessity for conducting war at the right time and on no account to delay it till their opponents considered it opportune to begin, as they would then run the risk of facing crushing odds.

Thus, according to von Kuhl, in 1907 Conrad was desirous of waging war with Italy, but his proposal was opposed by Ahrental, Foreign Minister, and by the Emperor. Again, during the crisis of 1908–9, Conrad was in favour of deciding the quarrel with Serbia by recourse to arms. His idea was to annex that country; in his opinion this would, so far as could be foreseen, be the last opportunity for a successful war with Serbia. These opportunities having been allowed to lapse, Conrad endeavoured to prepare the Austro-Hungarian armed forces for the coming fight for existence, but met with much obstruction. Von Kuhl questions whether the Monarchy was virile enough to take the line of escape proposed by Conrad.

In 1909 Conrad and Moltke were collaborating in the event of a common action. The latter deplored the failure of Austria to make use of her opportunity against Serbia. The agreements arrived at, says von Kuhl, had great influence in the opening phases of the campaign in the East in 1914. It was agreed that Germany should first employ her main forces against France in order to obtain a decision in that quarter, after which the main forces of both countries were to be employed against Russia. Meanwhile the Germans were to hold the Russians with 12—13 divisions in East Prussia, while Austria carried on the campaign alone. Moltke estimated that Germany would obtain a decision against France in three to four weeks. Von Kuhl stated that the movement of German troops to the Eastern Front was actually commenced "according to plan" under the mistaken notion that a decision had been obtained in the West.

According to the agreement, Austria was free to commence operations against Russia in whatever way she might decide. The situation obviously became increasingly difficult if Russia were to begin an offensive after Conrad had dispatched strong forces against Serbia, in which case only a negligible force would remain in hand to meet it. Moltke desired to leave his commander in the East a free hand; but, as a result of Conrad's importunity, he definitely pledged himself to attack in support of the Austrian offensive. Conrad maintains that the agreement was killed by the German failure on the Marne, and that the Austrians were left to bear the brunt against a much superior enemy single-handed, and did so successfully.

Von Kuhl questions the wisdom of Conrad's course of action. After dwelling on the geographical disadvantages of the situation, he emphasizes the difficulties inherent in delivering an attack from a central point on an enemy disposed on a wide arc. In addition, he points out that Austria had made the further mistake of detaching half its armies against Serbia, apparently in the vain hope of restricting the war to that country. He should have realized the futility of this.

In conclusion, von Kuhl condemns the two simultaneous offensives against Russia and Serbia, on the lines actually carried out, as doomed to failure.

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The Examination for the Admission to the French War Academy, 1922. —Von C. draws as his conclusion from a study of the questions set in the above examination, that the French encourage a perfect knowledge of the regulations and their application to the solution of the problems, in contradistinction to the Germans, who prefer to test the candidate's power of arriving at a decision and capacity for taking responsibility, together with a logical appreciation for the solution offered and the writing of clear and concise orders. He points out that, whereas the Germans demanded only a general knowledge of the particular period of military history set and tested the candidate's aptitude for applying the lessons learnt to later and present-day problems, the French require a detailed knowledge of the campaign, and set direct questions on it. It is suggested that campaigns are deliberately selected so as to fire the imagination of the young officer. After examining the French treatment of the subjects of International Law and Geography, von C. is of the opinion that the examination is framed with a view to promoting purely military knowledge and to direct the national aspirations towards a selected goal.

In conclusion, von C. points out that knowledge alone does not ensure success in war, but rather the power of initiative developed in the individual. A lesson can, however, be learnt from the second intention, *viz.*, the focussing of the youth of military age on a great national ideal.

No. 48.—The first instalment of an article eulogizing the work of the captive balloons in the German offensive between Arras–La Fère, in March, 1918, appears.

A Danish correspondent contributes an article in which he records the results of the great Parliamentary Commission for the reorganization of the Danish armed forces. Every member made his own separate proposal, no two members agreeing. The proposals ranged from complete military disarmament and the substitution of a civilian reserve police force, 6,000 strong (proposed by the Social Democrats) to an army of peace strength of 13,000, expanding to 150,000 in time of war (proposed by the Generals).

As the Left and Right parties together have a majority in the House, he thinks it probable that the compromise will be more or less based on the proposals made by the Left, which takes up for a standing army 6,700, expanding to 67,000 on mobilization. Even this would not provide for any reduction in annual expenditure.

The correspondent points out that the Left (or Peasant's Party) has always been Germanophobe. They desire to transfer two-thirds of the Army to Jutland. Military opinion also recommends "paying great attention to our Southern neighbour." Germany should realize that her neighbours have no intention to disarm.

A Hungarian correspondent records that the Treaty stipulations respecting the Hungarian Army have now been complied with. Hungary remains with a professional army numbering 1,750 officers, and about 33,000 men. They are said to be organized in seven brigades, four independent regiments of Hussars, four independent batteries and three pioneer battalions. Each brigade is given as consisting of two infantry

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regiments, each of three battalions, one cyclist battalion, one squadron of Hussars, one mixed artillery detachment and complement of mine-throwers, telephonists, and A.S.C.

Von W. deplores the new reform law for the Dutch Army, which he summarizes as being an acceptance of the Militia principle, always, in his opinion, a very doubtful step for a nation averse to military pursuits. He estimates the war strength of the Army as fifteen times the peace strength. Considerable economies are effected, but involving, he thinks, great sacrifices from the military point of view.

An article appearing in *Voena i Mir* ("War and Peace"), a new Russian journal published in Berlin, is reviewed. According to the author, the inadequate training of the higher leaders was abundantly proved in the late war. This made them too dependent on their General Staffs, tending to lessen their authority. The French, it is stated, recognized the need for such training and had introduced a *Centre des Hautes Etudes Militaires.* The war intervened, however, before appreciable results were possible. England was wholly unprepared for the problems of a Continental war. In the opinion of the *Militär Wochenblatt* these criticisms are in the main justified. The French have entirely remodelled the training of their higher commanders since the war. The courses given ensure that future leaders are not only efficient as soldiers, but also not lacking in political and economic knowledge. This, it declares, is a new and most noteworthy departure.

In an article entitled "Training of Officers in the Czecho-Slovakian Army" it is stated that not only Poland, but also Czecho-Slovakia are taking the French Army as their model. Particulars are given.

No. 49.—In a Francophobe article, Lucius Cincinnatus depicts that country as being at the root of all trouble in Europe. He takes comfort in statistics according to which, notwithstanding her losses in territory, Germany will, in 1940, possess a population twice that of France, and more than have made up the leeway incurred in surrendering two provinces.

Captain Mischer concludes his article on the work of the captive balloons in the 1918 offensive.

Italy is stated to be cutting down her army expenditure. 800 active officers are said to have been relegated to the reserve and are to be followed by a further 3,000 to 4,000 next year. Reductions in the rank and file are also being provided for.

Various reasons are assigned for Italy's growing loss of power in the arena of foreign politics. By the Treaty of Lana she is represented as being confronted with an alliance more dangerous to her than Austro-Hungary ever was.

In an article, Captain Prigers condemns the hostile attitude adopted by the Union of present and former professional soldiers towards the officer caste. Membership of this Union has lately been forbidden to serving soldiers.

No. 50.—Nothing of special interest.

H. DE C. TOOGOOD, *Captain, R.E.*

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REVUE MILITAIRE GÉNÉRALE.

May, 1922.

The Military Potentialities of Germany To-day.—By General D'Urbal. Under present circumstances Germany could not take the initiative in a war. Her peace-time force is strictly limited, and can only be considered as the framework of her war units; but her large population must, in the end, ensure her numerical superiority. Her mobilization must be slow, whereas France should have with the colours a nucleus sufficient to enable her completely to mobilize her whole army at once. Germany requires time, and will not depend on diplomacy alone to ensure it. Time can always be gained by retiring the base of concentration, but this means loss of territory; and when the latter includes the Ruhr basin and Essen, it is a matter for grave consideration. Her better plan would be to depend on the resistance of a strong covering position, not on the Rhine, for that would assume too great an inertia on the part of the adversary. The mountainous region stretching parallel to the Rhine and 30 to 50 kilometres to the east of it offers a strong defensive position of suitable depth; but Essen is in front of it. It would be worth taking the risk of France advancing into the dangerous corridor between the Rhine and the Dutch frontier and to hold the Rhine from that frontier to Ruhrort and the Ruhr, from Duisburg to Werden, after which the line would probably run past Solingen, Lingen, Wetzlar, Hanau and the river Main as far as Mittenberg, and thence through the Black Forest to Switzerland. Behind this line, held by local levies, the Germans could complete their mobilization and concentration. The Rhine would not be entirely abandoned; light units would take the field in the valley to evacuate mobilizable men, horses and material, while disputing the ground as far as possible, or even to facilitate an advance of the main body to the Rhine, should France give the opportunity. To furnish troops and material for the defensive line of 500 kilometres, recourse must be had to camouflage. It will be bad luck if, in Essen and other places, a quantity of material could not be concealed, and the 70,000 workmen might contain a few thousand soldiers, while sports' and veterans' associations could provide a force sufficiently trained to offer some resistance until the main covering-position is occupied, and could be constituted, ultimately, into regular units. Once firmly posted in the covering-position, the Germans would have France at their mercy, could bide their time, dare her to advance on a new war of attrition, and could detach a few divisions to take Poland in rear in her war with Russia, and so open the way for the Red armies. When they have incorporated Austrian units in their army and arrived at their full strength, a frontal attack, combined with infiltration through Holland and a strong flank attack by the Swiss plain on Dijon and the valley of the Seine, would probably oblige the French to abandon the Rhine and fight a battle in the open with all the advantages against them.

If this forecast is correct, strategical railways, leading to and along the covering position, may soon be commenced, concrete platforms—for tennis courts—may be expected, and civil aviation will never have

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enough hangars ; but if the last two, and stocks of warlike stores, and military organizations disguised as sports' clubs, may escape the attentions of commissions of control, the railways will be enough to show the intentions of the German military authorities.

The Revision of the Regulations.—Continuation of the article by "Lucius."—*Sixth period—The Great German Offensive in the Spring of* 1918 *and the Reappearance of Open Warfare.* Taught by experience on their Eastern Front, the Germans fully agreed with their Chief, Ludendorff, in the possibility of breaking the line and developing the success. The submarine war entered into in February, 1917, had not fulfilled expectations, and the arrival of U.S. troops in France now appeared inevitable, while the attack had proved its superiority to the defence. As a rapid decision was imperative for the Germans, Ludendorff concentrated 203 out of a total of 241 divisions on the Western Front, a superiority of 30 divisions over the Allied Forces, and, abandoning strategy, selected the neighbourhood of St. Quentin for his attack, for the tactical reasons that it was the weakest part of the Allied line, and the ground offered fewer difficulties.

The characteristics of the German offensive doctrine were surprise in the preparations and rapidity and continuity in the execution.

1*st.*—*Surprise.*—Stragetical surprise was sought by manœuvre (the same signs of attack developed in Champagne and Picardy), and by concentration of the reserves in a central position so as not to reveal the real plan. Tactical surprise was obtained by careful concealment of the preparations, by strict control of traffic, by a drastic reduction of telephonic messages and correspondence, by secret transmission of orders which were invariably copied by hand by an officer, by assembling the troops at night, and, except in the case of artillery, only at the last moment, and by the brevity and violence of the artillery preparation.

2*nd.*—*Rapidity and Continuity in Execution.*—The guiding principle enounced was that rapid progress gives the maximum of protection and ensures success, consequently (*a*) the infantry attack, once opened, must be pressed on as rapidly and as far as possible without halt ; (*b*) the enemy's artillery, which is the backbone of the defence, must be overwhelmed in the first onslaught, which should reach a depth of eight kilometres or more, up to or beyond the enemy's artillery position ; (*c*) since the artillery cannot change position as quickly as the infantry, the attack will comprise two stages, (1) the battle of position, in which the infantry is supported by artillery, and (2) the battle for the intermediate zone, commencing when the infantry has partly lost touch with the artillery and the conduct of the fight devolves on the junior commanders, for which reason infantry must be given means to carry on the action with their own resources ; (*d*) strong points need not be captured, until, by permeation into the intermediate gaps where resistance is less, it will be possible to attack them in flank and rear ; (*e*) to sustain such an attack, reserves must not only be numerous, but must not be engaged without real necessity, *i.e.*, only when the front line units are at their last gasp..

3*rd.*—*Employment of the Larger Formations.*—Under such conditions, the battle presents a series of successive efforts aiming at objectives

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as distant as possible to ensure rupture, and then open warfare ; in its initial stage a comparatively easy matter with all arms acting in combination. In order to husband the reserves, front-line divisions will occupy narrow fronts of 1,800 to 2,000 metres and must not expect to be relieved for several days. The great point is to hold back the reserves until it is absolutely necessary to use them, with a view to maintaining progress to the greatest possible depth. The commanders' duty is, therefore, (*a*) to economize infantry ; (*b*) never to send his reserves into action until the favourable moment, and in places where the advance is making the best progress ; (*c*) to maintain a sufficiently deep formation to cover the flanks and ward off counter-attacks ; (*d*) to reconstitute his reserves during the battle to ensure continuity of effort, and to maintain pressure on the enemy, especially where success has been obtained ; (*e*) to make certain of good intercommunications and to follow the fight closely, all staffs should be in the field, and those of the divisions well to the front.

4th.—Employment of the Various Arms: Infantry.—Infantry will not only have to occupy the ground, but must be able to overcome all resistance without artillery aid, to which end it was ordained that each regiment should have under its orders a field battery from the divisional artillery and six *Minenwerfers*, in addition to its heavy and light machine-guns, rifles, bayonets, grenades and trench-mortars. Even in the first stage of the battle, the artillery barrage might fail somewhere. In the second stage the attack ceases to be automatic, and the enemy artillery position, once captured, assumes the character of open warfare. Mechanical method fails, and individuality finds scope. The pursuit of the enemy must be rapid and continuous ; units do not wait for each other, but must guard themselves effectively against unforeseen resistance. If the enemy halts to fight, he must be quickly driven in, even at the expense of considerable loss to the attackers. Should the enemy have time to occupy a rear position with fresh reserves, the zone in front of it must be cleared of his troops and the position reconnoitred. The ensuing attack will be ordered by superior authority with all arms combined and preceded by an artillery preparation ; in fact, the same process as before, but greater rapidity is possible. As in open warfare, so in the battle for rupture, the junior commanders from company and battalion upwards, must, once the artillery barrage commences, be allowed full liberty of action and tactical initiative, for on these depends the development of the success.

Artillery.—Brevity and violence in the artillery preparation are obtained by expert arrangements obviating the necessity for ranging, and by the use of gas-shell for neutralizing, instead of destroying, the hostile artillery. But as neutralization is only temporary, the infantry attack must follow quickly. Counter-battery fire for systematic destruction should, however, be increased before the infantry advance. *Minenwerfer*, the range of which now attains 2,000 metres, should be employed during the preparation for the destruction of obstacles and other defensive organizations to set guns free for other duties. As to the duration of the artillery preparation, the paralysis of the artillery and destruction of the essential features of the defence requires several

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hours. Efforts to secure surprise must not lead to hasty and partial artillery preparation. A Note of 16th February lays down two hours for the length of the artillery preparation against the hostile artillery and as much against the infantry positions. It should, as a rule, commence at night, so as not to detain the infantry too long in their position of departure. In the first stage the rolling barrage will be executed by the largest possible number of batteries, and allow the infantry to advance without halting. It will be double, mortars and heavy guns aiming in front of the field artillery. Ludendorff laid down that a battery of four field guns should engage a front of 70 to 80 metres, and preferred that the advance of the barrage should be regulated by visual signals from the infantry rather than by a fixed time-table. In the second stage it is necessary that the infantry should never be without powerful artillery support—a most difficult task; the guns which have prepared the way can only partially fulfil it, and other powerful and mobile guns are required. The artillery should be distributed in three groups—the regimental guns marching with the infantry, the batteries intended to change position and participate in the advance to the attack, and those remaining in position—the foremost of which will cover the advance of the preceding. Experience gained at Riga led to the abandonment of entrusting the artillery command to the commander of the divisional artillery reinforced to that end, and to placing it in the hands of a special chief, generally the commander of the corps artillery. Thus, for counter-battery work, the Germans adopted the same procedure as the French.

Aviation.—As the German air force was decidedly inferior to that of the Allies, it was only expected to attempt mastery in the air at the moment of attack to assure the operation of the infantry *liaison* planes which flew low and brought machine-guns to bear on the hostile infantry. Distant reconnaissance was undertaken by isolated machines, flying at a great height. Night bombardment in the back areas was entrusted to complete squadrons. It is noteworthy that none of Ludendorff's rules and instructions mention the use of cavalry for developing the success after a rupture.

A. R. REYNOLDS, *Colonel.*

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IMPERIAL ORGANIZATION.

A Lecture delivered at the S.M.E., Chatham, on 16. 2. 22, *by* MAJOR A. E. W. SALT, *Army Educational Corps.*

THE subject of Imperial Organization looms so large in connection with promotion and Staff College examinations in the Army that, merely from an utilitarian standpoint, no apology is necessary for its consideration. While, however, it is easy to lay stress on the need for accurate and comprehensive knowledge, it is to-day even more true than when Burke uttered the words nearly a century and a half ago that "the whole fabric of the Empire is so illogical, so wholly without parallel in history, so impossible to define, so hard to understand or explain, that, to the orderly mind," (as to the unfriendly German eye) "it often appears to be a bundle of sticks with no containing bond except the name."

This diversity at all points and in all phases, a diversity of status and stature, of lands British by settlement, by free-will, by cession, by purchase, by lease, by forcible annexation, of Spheres of Influence and Protectorates, of Crown Colonies of differing denominations, of territories under Mandate and territories under Chartered Company, of Dependencies and Dominions and Free States, of parliaments and democratic assemblies and no legislatures at all, scattered to the four corners of the earth, is the amorphous diversity of the world's greatest empire.

Yet here and there are traces of a containing thread, underlying reasons for apparent anomalies, and always the proud sense of natural growth. "A man casts seed into the ground, and sleeps and rises up night and day, and the seed springs and grows up, he knoweth not how."

Diversity is the very essence of growth on natural lines. The more a plant grows the more it varies from the original seedling. The Empire is natural, not artificial. There may be no common Government, no common legal or fiscal system, no common navy or army or air force, no common political machinery or citizenship, no common race or religion or social conditions, the British Empire may be neither British nor an empire, but it is the greatest illustration of self-growth the world has ever seen.

A few salient facts as to the size, population and power of this wondrous entity may serve as a reminder. In January, 1922, the British Empire covered roughly 12¾ million square miles, over one-

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fifth of the world's total area, and over a quarter of its land surface. It contained some 455½ millions of inhabitants. The largest number of square miles in any continent was 3⅞ millions in Canada, followed by Africa, Australasia and Asia in the order named, Europe lying far in the rear, and the area of the United Kingdom being less than a hundredth part of the whole.

In population, Asia headed the list by a very long distance, India contributing 70 per cent. of her total. Europe followed, the United Kingdom, with 47 millions of people being responsible for over 10 per cent. of the whole. The continents of Africa, America and Australasia, with the greatest possibilities for human expansion, held the smallest number of human beings. The density varied from nearly 400 people to the square mile in Europe to 160 in Asia, 16 in Africa, 3 in North America (Canada) and barely 2 in Australasia. Curiously enough, the small island of Malta vied with the United Kingdom as one of the most thickly populated portions of the globe.

Tried by test of revenue, Europe—that is the United Kingdom—was easily first with over £1,000,000,000; Asia, of which India contributed £135,000,000, was second with £160,000,000; America third with £88,000,000; Africa fourth with £80,500,000, and Australasia last with £79,000,000.

As against this, however, Europe—"the old country"—with its long record of wars and the grievous burden of its most recent struggle, is bearing a weight of national debt amounting to over £7,500,000,000, Australasia, partly because of its gallant borrowings to build up the future, owes £580,000,000, and Africa carries a load slightly less than half that of Australasia. The whole debt of the Empire—six times as heavy as in 1914—amounts to the colossal sum of £9,500,000,000.

A more pleasant aspect is the view of the resources of the Empire. She produces 60 per cent. of the world's gold (40 per cent. in the Transvaal) and possesses 40 per cent. of the world's cotton spindles and approximately the same percentage of the world's shipping tonnage (36 per cent. under the flag of the United Kingdom). Further, she has a practical monopoly of tin, nickel, timber and jute.

The nucleus of this stupendous aggregate of people, lands, wealth, and products is the United Kingdom, with an area of slightly over 121,000 square miles and a population bordering on 47 millions, or 72 per cent. of the white population of the Empire.

The nominal ruler of the Empire is a Sovereign King—he is also Emperor of India and Lord of the Dominions over the seas—whose family has, by male and female descent, sat on the throne for well over a thousand years.

The practical ruler is the Prime Minister, supported by a body of individuals known as the Ministry, all of whom must be in one or other of the two Legislative Houses—the hereditary House or House

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of Lords or the elected House—the House of Commons. Each of these Ministers functions not only as an adviser to the Prime Minister, and through him to the Sovereign on matters of high policy, but also acts as the executive head of a Department of State. Those in charge of greater departments form a more intimate body of advisers which is known as the Cabinet. Certain departments have a more specific relation to the Empire, or deal solely with overseas questions. Among the former will be found the Home Office, the Admiralty, the War Office and the Board of Trade; among the latter the Colonial Office and the India Office.[1]

Even within the limits of the home-country—the sea-girt island, "set in a great pool like a swan's nest"—diversity begins to assert itself.

Subject to the Home Office are the three entities of the Channel Islands, the Isle of Man and Ulster; subject to the Colonial Office is the newly-formed Irish Free State. The Isle of Man, as the Channel Islands, only bound by Imperial Laws when definitely mentioned, possesses its own administrative body—the Court of Tynwald—consisting of a Governor, appointed by the Crown, a nominated Legislative Council of Ecclesiastical[2] and Judicial dignitaries, and a Legislative Assembly—one of the oldest in the world, elected for seven years by municipalities and local divisions ("sheadings"). Moreover, there still remains the primitive custom of ratification of the laws by an island "moot" of all male Manxmen of full age, assembled each year on the sixth of July, the anniversary of Manx independence, in the churchyard of the capital town of Douglas[3].

The Channel Islands have also a Crown-appointed Lieutenant-Governor, and, as well, two Bailiffs, one for Jersey and the other for Guernsey, Alderney and Sark, which is regarded as a dependency of Alderney. Each separate jurisdiction has also its "state," consisting of two classes—"Jurats," elected for life by parish ratepayers, parish rectors, and constables (mayors) of parishes, and "Deputies" elected for three years.

The position of Ulster is unique. By the Government of Ireland Act (1920), "Northern Ireland," comprising the six counties of the

[1] There is no Imperial Parliament with representatives of the Dominions and Colonies as such. The most practical suggestions for its foundation and composition may be found in a recent article by Lord Raglan.—*Nineteenth Century and After*, August, 1922 (pp. 217–221.)

[2] The Bishop of Sodor and Man has a seat in this Council, but not in the Imperial House of Lords.

[3] Similar "moots" exist in the Swiss cantons of Appenzell, Glarus, Unterwalden and Uri.

27 laws were promulgated by the Tynwald in open "moot" on July 6th, 1922.

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province of Ulster with the Parliamentary boroughs of Belfast and Londonderry, was granted a full share of self-government, but allowed to retain her members in the Imperial Parliament. Her own Parliament consists of a Senate of 26 members, 24 of whom are elected by a House of Commons of 52 representatives of the six counties, Queen's University and the borough of Belfast, the Lord Mayor of Belfast and the Mayor of "Derry" becoming senators *ex officio*. Certain reserved powers, such as the making of peace and war and of treaties, coinage, trade-marks, the granting of titles and dignities are retained by the Imperial Government. In all other respects Ulster has the status of a self-governing Dominion wielding executive power over the north of Ireland and controlling Irish service through responsible ministers.

Had the Act of 1920 been adopted in all its provisions, a similar bi-cameral form of government would also have been established in "Southern Ireland" (the rest of the country).

There was, however, already in existence a self-constituted Legislative House ("Dail Eirann"), sitting in Dublin, dominated by one Eamann De Valera and containing, apparently, a majority in favour of separation and an independent Irish Republic. Some of the most vigorous and intellectually alert members of the "Dail" were not, however, satisfied with its unrecognized position, and, after much debate, reasonable and acrimonious, an agreement was reached between representatives of the "Dail" and of the Imperial Cabinet under which Southern Ireland should "take her place in the great association of free nations." In January, 1922, after violent opposition, this agreement was ratified in the "Dail" by a small majority, and a month later the Irish Free State Bill became law. The horizon at the moment of writing is still clouded. The Provisional Government is functioning with some difficulty, but a general election under the new conditions has taken place and there is a recognized legislative assembly other than the "Dail." When the storm lifts, Southern Ireland is to be, not as De Valera and his followers would wish, "an independent and sovereign state," but a dominion such as Australia or Canada, with complete autonomy in taxation and finance—with her own judges and courts of law, with her own armed force for home defence; with her own constabulary and police, and with entire control over her own postal service, lands, education, housing, labour, transport and trade[1].

Moreover, the six guarantees with which this full and free grant of privileges was accompanied were natural to the intimate geographical and strategical relations of Ireland and Great Britain, and vitally

[1] The disbanding of the R.I.C., the issuance of Irish stamps, and the publication of Irish revenue statistics are recent notable incidents that prove the reality of the Irish Free State.

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essential to the safety of the United Kingdom. Failing the constitution of an independent republic, Southern Ireland was bound to accept control of the Irish seaboard by the Imperial Navy, a limitation of the Irish Territorial Force comparable with similar limitation in other parts of the United Kingdom, provision of proper facilities for Imperial defence and air communications and voluntary recruiting in Ireland for the Imperial Forces.

The Irish Free State Bill provides a reasonable, sane and safe settlement of a long-standing problem. When law crystallizes into fact, Southern Ireland will take her place with Canada, Australia, New Zealand, South Africa, Newfoundland, as a self-governing Dominion.

The status of these politically older Dominions is rooted and grounded in History. As soon as Englishmen left the motherland—not for casual, impermanent trade, but for permanent settlement—they willed to avail themselves of the " ancient rights and liberties " of which they had often been tragically deprived in the land of their upbringing. Representative Institutions were an essential condition of these " rights and liberties " and in Puritan New England, no less than in Royalist Virginia, Englishmen governed themselves on the traditional lines of an assembly elected on a wide franchise.

They were white men living under climatic conditions that support an active white population, and it may be taken as a general rule that where the parallel lies between 10 and 49 degrees, and whites can live and bring up their children, self-government will naturally follow. The rule is not, indeed, absolute—nothing in the scheme of Imperial organization is absolute—for it was adopted in Barbados, which lies between 10 degrees north and the Equator, and the slave population vastly outnumbered the whites, and was not adopted in the Falkland Islands, with a predominant English population under good conditions of living ; but it holds good in South Africa (between 35 and 10 degrees), in New Zealand (between 34 and 48 degrees), in Canada (north of 49 degrees) and in dry, hot, healthy Australia (between 11 and 39 degrees), and it is yet to be seen whether self-government will work out satisfactorily in Egypt, in Kenya, in India, or in the American colony of the Philippines—tropical homes of coloured races.

Representative Institutions are, however, but one stage in political progress. Canada—by way of example—has not merely self-government, she has responsible government and she is a Dominion. The two territorial divisions of Upper and Lower Canada along the reaches of the St. Lawrence—geographically equivalent to what is now known as Ontario and Quebec, governed themselves from 1791, but they were not united until 1839, until after the publication of the Durham Report—a document which every student of Imperial organization is bound to read—and the system of responsible govern-

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ment was not fully established until 1848. The linking of East and West—the unity of the Maritime Provinces, of Upper and Lower Canada, of the great vast spaces of the Middle West " for which the speech of England hath no name " and of British Columbia into one confederation—the Dominion of Canada—was not achieved until the British North America Act of 1871.

With a diversity of dates and by different ways the same operation is seen in Australia and South Africa. In the former the convict settlement of 1787 threw out shoots which by the middle of the XIXth century had grown into independent states, not to be federated, with the addition of Queensland, as a Commonwealth, until the second year of a new century. The tale of South Africa is one of tangled complexity, but at last, after the bitterness of the South African War, a peace of statesmen culminated in 1909 in the union of the four provinces. Before the end of the XIXth century also New Zealand and Newfoundland had stepped into their birth-right, without fusion of separate colonies or discordant races, and in 1914 the Empire possessed five great self-governing Dominions with their own parliaments and political machinery more democratic than that of the Mother Country.

Each of the five self-governing Dominions has a Governor-General, representing the Crown, an Upper House (Senate or Executive Council) and a Lower House or Legislative Assembly. As in Great Britain, there is also a fully responsible Cabinet.

In the federal Dominions of Australia and Canada each province or state has also representative institutions of a like nature.

The relations between the Federal and the Provincial Governments vary. In South Africa it was not deemed wise to bring the four provinces too closely together, and the term " Union " rightly expresses their loose constitutional relation to one another. In Canada the British North America Act would never have been worked in harmony if the Provinces had not been closely limited in power. In Australasia the states, originally all powerful, retained much of their power under the Commonwealth Act. The distinction between Canada and Australasia and South Africa may be gauged by a comparison of the significance of the words " province " and " state," of " Dominion " and " Union " and " Commonwealth." It is hardened into fact as we compare Federal Control of Railways in Canada with the variation of gauge on the State lines of Australasia, if we remember that only the last decade has witnessed an attempt at an Australasian, as distinct from a State, immigration policy, or run by chance into the jealous guardianship of State rights exercised by Queensland or New South Wales.

This, however, is interesting rather as an illustration of the intricate complexity of the wheels within the wheel. We must now pass on to a consideration of the relation of these self-governing Dominions

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to Great Britain herself, a relation radically altered by the Great War.

The events of the flaming summer of 1914 are too fresh to memory to need repetition. The pact of Empire[1] was faithfully and fully kept. The statement of the Prime Minister—"Every one of our self-governing Dominions, spontaneously and unasked, has already tendered to the utmost limits of their possibilities, both in men and money, every help they can afford to the Empire in a moment of need," was echoed in the Royal message of a month later[2]. "During the past few weeks the peoples of my whole Empire at home and overseas have moved with one purpose," and again ". . . all parts of my overseas Dominions have demonstrated in the most unmistakable manner the fundamental unity of the Empire amidst all its diversity of situation and circumstance."

And as the war went on, as the issues became more imperative and more clearly defined, more and more did the Empire and the Dominions make the war their own war. The Australian pronouncement," to the last man and the last shilling," accurately and simply expressed the feeling of the back-veldt Boer, the French Canadian habitant, the intransigeant Irishman nearer home. The two alternatives of refusal or neutrality vanished before the most complete, unswerving, unshaken acceptance of Imperial responsibility that the world had ever seen. But it must be remembered—equality of sacrifice has always borne with it sequent equality of right and privilege. Statesmen and publicists before 1914 had played seriously with the theory of constitutional equality within the Empire. The war shattered theory.

In 1911 it was easy to say "the authority for the conduct of foreign policy, the negotiation of treaties, the maintenance of peace, the declaration of war, cannot be shared." To-day, this particular theory—expressed in other words as "governing the Empire from the windows of Downing Street"—has perforce gone to the wall. Even the most casual observer may have gathered from the constitution of the Trianon Conference, the organization of the League of Nations, the make up of the Washington Conference, no less than from an Imperial Cabinet formed in war for war, that "signal partnership of Great Britain and the self-governing Dominions has passed from vision to reality."

But the Great War has brought about other changes equally significant if less obvious. Perhaps the greatest of these was seen in the meeting of the Imperial Premiers in the Imperial Conference of the summer of 1921—the proceedings of which should be read and re-read by anyone who cares to keep himself *au fait* with this

[1] "The Empire cannot be at peace and war at the same time." (Sir Wilfred Laurier.)

[2] September 10th, 1914.

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absorbing subject[1]. In the first place, this Conference—not of representatives, be it noted, but of Premiers—scrapped once and for all Imperial Federation with all the panoply of a written constitution defining in precise terms the relation between the whole and its parts.

Secondly, the Premiers of the self-governing Dominions were quite clear in their determination to keep an intimate finger on the machinery of Empire by constant and direct communication at least once a week with London. Such a resolve gives Sir Wilfred Laurier's phrase, "The policy of the Empire is to be decided by the Empire as a whole, and not by any part of it" a new meaning. Their decision in so many words amounted to this:—"All the members of the Great Dominions, as well as the Motherland, have an equal voice in the formulation of foreign and Empire policy. We are full partners of the Empire. We want to know the reasons for policy in Mesopotamia, Palestine, Russia, Egypt, Greece and Turkey." By such a declaration the Foreign Office becomes not a master but a mouthpiece (Mr. Lloyd George prefers the term "instrument"); and if the Foreign Office has declined in power, the Colonial Office has ceased once and for all to operate except by suggestion, it being clearly understood that the Colonial Secretary was present at the Conference solely as the spokesman of the Colonies and Protectorates. And lastly, if Mr. Hughes' proposal bears fruit—Imperial Conferences may meet in the future, not in London, but in Vancouver, and the centre of Empire may be shifted westward even beyond the range of the Downing Street outlook.

To the alarmist, this and other incidents—direct dealing by the League of Nations with South Africa and Australia with regard to mandated territory, the conduct of direct diplomatic negotiations between Wellington and Washington on the position of the Armour Meat Trust in New Zealand, the claim of Canada to independent representation at the Washington Conference and the expressed views of extreme autonomists—furnish a mournful presage of Imperial disintegration, "the subversion of Imperial unity and the end of all projects of co-operation between the Mother Country and the Dominions for common objects and common interests."

The commonsense optimist prefers to trust the words of Mr. Meighen of Canada—"the people expect me to keep in mind the spirit of distinct Canadianism and our sense of national status and responsibility, but Canada expects that every word uttered in her behalf shall be in full comprehension of the common interests of every portion of the Empire, and animated by devotion to the Empire as a whole."[2]

[1] These decisions were admirably summarized and analysed in the *Round Table* for July, 1921, and successive number.
The official record may be purchased from the Stationery Office for 9*d*.
[2] *Canada in the Empire, Nineteenth Century and After*, July, 1922.

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The last thing Britain wants to do to-day is to fuss about details, once this sentiment remains. We once lost colonies because we remembered them too well.

There is, however, one issue on which the Prime Ministers of the self-governing Dominions have not yet been able to join hands with the nominated delegates of India who were also present at the Imperial Conference of 1921. Not yet will Canada and her sister Commonwealths admit Indian citizens to their citizenship on the same lines as white citizens of the Empire. The visit of Mr. Sastri, who was one of the Indian delegates to the Conference, to Australasia may modify the situation. "The spirit in which Mr. Sastri's suggestions have been received has made India confident of a satisfactory solution of *all* questions outstanding between India and Australia and will further strengthen the ties binding the two countries as partners in the Empire."[1]

Such limitation must place India in a slightly lower position within the Empire. Acute intelligence, infinite capacity for culture and progress, a well-developed civilization, older than our own; no one denies that to India. But India is, as yet, in a transition stage. The Mutiny is only two generations distant. There have been unpleasant incidents within our own memory.

If it is the declared policy of Parliament to provide for the necessary association of Indians in every branch of administration and to further the gradual development of self-governing institutions with a view to the progressive realization of responsible government in India as an integral part of the British Empire, it is no less the bounden duty of native Indians to show by their attitude towards the Montagu-Chelmsford reforms (consolidated in the Government of India Acts, 1915 to 1921) that they possess the broad political sense essential to the government of so vast and so diverse a country.

To-day native India has its native representatives on the India Council, its Central Legislature of two Chambers, which assists the Secretary of State for India at home, with a native majority in the Lower House or Legislative Assembly; while in the Provincial Governments elected Indian Ministers belonging to a Provincial Legislative Council practically control local self-government, medical administration, public health and sanitation, public works, agriculture, fisheries, co-operative societies, excise, registration, development of industries, adulteration, weights and measures, and religious and charitable endowments.

All this is a radical step forward from the quondam method of sole administration by the Indian Civil Servant. In places it does not satisfy—it is not responsible government. There is still the para-

[1] Telegram from the Earl of Reading, Viceroy of India, to Lord Forster, the Governor-General of Australia—quoted in *Daily Telegraph* of July, 17th, 1922.

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mount power of the Governor-General in Council—there is still the large official majority in the Central Council of State in India in the advisory India Council.

"Why," say your extremists, "have you been so kind to Egypt? We also want independence with guarantees." The answer is not so difficult as it appears at first sight. Absence of caste, unity of religion, common origin, a common dialect, the presence of the Englishmen under an "ill-defined and temporary protectorate" made it obvious that, sooner or later, we were bound to step down and out of Egypt. That there is no India as yet—not even in name—implies continuance of tenure and slow, if steady, political progress.

Beyond the self-governing Dominions, moreover, only one small island, and this because of the beginnings of our ownership, possesses more political independence than India. Malta, with its insignificant area (1½ square miles) and dense population, came into our possession by the voluntary will of the Maltese, with the assistance of the British Navy, during the Napoleonic wars, and has been since 1921 under a Dyarchy; local affairs being entirely administered by an elected Senate, while matters of Imperial moment are dealt with by a nominated Executive Council, consisting of the Lieutenant-Governor, a legal adviser and a representative of the three arms of the fighting forces. Perhaps Malta may be said to touch Newfoundland even more closely than India, as, like Newfoundland, despite her political freedom, she does not send her representatives to the Imperial Conference.

In the *Statesman's Year Book* there is a paragraph headed "India, the Dominions, Colonies, Protectorates and Dependencies." This assumes five classes of possessions. We may now turn to the third class. The term "Colony" is an abbreviation of "Colony not possessing responsible government," and is not, therefore, applicable to the self-governing Dominions or Malta. Sometimes "Crown Colonies" is loosely used for "Colonies," but this should properly be restricted to those Colonies such as Hong Kong, in which the Crown retains control of legislation[1], and not given to Colonies with elected legislatures of the type of Ceylon or Cyprus. In all colonies there is a Governor nominated by the Crown, an Executive Council of officials and unofficial Crown nominated members, and a Legislative Council, sometimes of officials, sometimes of officials with a nominated or elected unofficial leaven. When this latter is entirely or mainly non-official and elected, there is generally a reasonably large number of whites of European (not necessarily British) blood within the community, or natives of intelligence and standing (the Maori, the Zulu, the Cingali, may be cited as obvious examples of

[1] As in the "Crown Colony" Department of the Colonial Office. The purest type of a Crown Colony is Gibraltar, where the Governor combines in his own person all executive and legislative functions.

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this type), or a strong historical tradition of representative government[1].

[1] The following is a summary of the status of the Colonies at the end of 1920. With the march of political ideas it needs constant revision :—

	Executive.	*Legislature.*
ASIA.		
Ceylon	Official majority.	Elective majority.
Cyprus	Equal numbers of officials and unofficial members.	do.
Hong Kong	Official majority.	Official majority.
Strait Settlements	Officials only.	do.
AFRICA.		
Kenya (held under mandate from the League of Nations)	Official majority.	(Elective element) Official majority.
Mauritius	do.	do.
Seychelles	do.	Equal numbers of officials and unofficial members.
Nigeria	do.	Official majority.
Gambia	Officials only	do.
Gold Coast	do.	do.
Sierra Leone	do.	do.
AMERICA.		
Bermudas	do.	Officials only (with Representative House of Assembly.)
Bahamas	do.	As Bermudas.
Barbados	do. (and executive committee.)	do.
Jamaica	As Bahamas.	Unofficial majority (Elective element.)
Leeward Islands (Federal)	Officials only.	Official majority. (Elective element.)
Antigua	do.	Equal numbers of officials and unofficial members.
Montserrat	do.	Officials only.
St. Kitts and Nevis (with Anguilla)	do.	Equal numbers of officials and unofficial members.
Virgin Islands	do.	None.
Dominica	do.	Officials only.
Trinidad	Official majority.	Unofficial majority.
WINDWARD ISLANDS.		
Grenada	None.	do.
St. Vincent	do.	do.
St. Lucia	Officials only.	Officials only.
AUSTRALIA.		
Fiji	Official majority	Official majority. (Elective element.)

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These, at any rate, are the guiding principles on which the grant of representative institutions is bestowed. But there are apparently outstanding exceptions. The first principle is clearly apparent in Hong Kong and the Gold Coast, where the native population outnumbers the white sixty and forty-fold respectively, it is seemingly violated in Barbados, with its plantations densely crowded with negroes. Here, however, the third rule comes in. Barbados has three centuries of British tradition, Hong Kong and the Gold Coast barely a hundred years. Again, if the Seychelles, French by blood, remains a Crown colony, while Ceylon boasts a more advanced form of government, it is difficult to start building up the nucleus of a self-governing dominion in a colony that may depend for its revenue on the sale of its postage-stamps or its annual output of turtles. For it must be remembered, once a political step is granted, there is no going back, unless a repetition of the Jamaican revolution is desired[1].

Moreover, the clamour for representative and responsible government grows louder and more incessant each year. The strong words of Mr. Churchill to Kenya last year—"Democracy implies civilization in an advanced form," are pregnant with counsel, when every colony in the West Indies, from Trinidad, with nearly 400,000 people, to tiny St. Kitts, one-fifth the size of the smallest county borough in England and Wales, is insisting on its constitutional rights.

One solution which has suggested itself as a method of granting responsible government is that certain colonies should be united geographically into a *bloc* under the charge of a High Commissioner. Six of these *blocs* are proposed—Mediterranean, West Indian, West African, East African, Indian Ocean and Australasian; controlled respectively from Valetta (Malta), Port of Spain (Trinidad), Lagos, Nairobi (Uganda), Port Louis (Mauritius), and Suva (Fiji).

The term "High Commissioner" is already familiar as applied to the resident representative in London of the self-governing Dominions and of India. Viewed from the standpoint of administrative reform, the scheme has obviously much in its favour. It would at least lighten the burden of the Colonial Secretary and provide more effectually for common interests; it would tend to organize Imperial trade more closely, and would undoubtedly effect necessary economies. On the other hand, there are certain apparent difficulties, not the least being the political subordination of a great Empire like Malaysia[2] to a small colony of the type of Mauritius.

[1] Jamaica was granted Representative Council in 1661, but had to be deprived of it in 1866 owing to negro riots.

[2] In 1860 one white man lived between Bangkok and Singapore. Malaysia now produces one-third of the tin and two-thirds of the plantation rubber of the world. In 1920 its trade—exports and imports combined—amounted to £297,000,000, three times that of Greece. The word "Empire" would not seem to be a misnomer.

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We may now pass to Protectorates. Protectorates are native states under British control. The ruler of a Native State is certainly an aristocrat and often a *sahib*. In most cases he has a long tradition of hereditary kingship, and has accepted British suzerainty after years of honest fighting. He deeply respects us and our rule,[1] but he wishes to be sovereign within his own dominions, to be sure of security of tenure or descent—provided his conduct is satisfactory—and to be protected against foreign intrigues and pseudo-democracy. Under these circumstances he does not object to the deprivation of the independent right to make peace or war, or the limitation of his military forces, while on our part we assist him by means of a Resident or Agent. The Resident is the sole representative of a foreign power at his Court, and has a very wide discretion—under instructions from home—in the selection of the next heir to the throne, the education of the royal princes, and the deposition of undesirables.

In certain Protectorates, notably those on the frontiers—"buffer states"—we also grant a substantial subsidy for defence.[2] It is in India that most of these Native States are found, the largest being Hyderabad with a population of 13½ millions, and the smallest Seilan, with fewer people than Chatham. Some of these deal directly with the Central Government of India, others of the second class are politically responsible to the Provincial Governments.[3]

There are also, in Asia, the Federated Malay States, Sarawak, Brunei on the island of Borneo, and, nearer home, Mesopotamia, or, to give it its modern designation, Iraq. The first-named comprise Perak, Selangor, Negri Sembilan and Penang, and preserve their local autonomy, but consider their common interests—in conjunction with representatives of the tin and rubber interests—in a Federal Council. On the same Peninsula there are also five smaller states not included in the Federation.

Sarawak is in a most peculiar position. The ruler of the native state in this case is not a native but an Englishman—Rajah Chas. Vyner Brooke—great nephew of the original James Brooke, who obtained the first grant of territory from the Sultan of Brunei in 1842. This cession has since been considerably increased, and the whole country saved from barbarism by the wise rule of successive Brookes.

The position of Iraq is at present undefined. In her case the mandate comes from the Supreme Council as the result of the treaty with Turkey. It may be expected to develop into a Protectorate,

[1] The attitude of the Indian Protectorates to Lawrence, or in more recent years, of the Afghan to Sir Henry Dobbs, is typical of this heartfelt respect.

[2] Baluchistan (Kalut), for instance, receives an annual subsidy of 100,000 rupees.

[3] The Council of Princes in India, though its views are received with respect, is not a properly constituted constitutional body.

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almost an independent Kingdom, under Emir Feisal, a nephew of the ruler of Medina, Feisul being at present the titular ruler, but British troops and civilian and military advisers are still retained, much as in Egypt, while the country remains in an unsettled state.

In Africa, Basutoland also has its Protectorates—in Somaliland, Nyasaland, Zanzibar and Bechuanaland—the two last coming under the immediate control of the Union of South Africa, while in the far-off Pacific, Tonga may be placed in the same category.

Further, certain Protectorates, such as Togoland, the Cameroons, Kenya, Tanganyika, South West Africa, New Guinea and Samoa, only remain so long as the League of Nations is satisfied with our government. These possessions are held by Great Britain or a self-governing Dominion under mandate. That is to say, they were handed over to be governed as seemed best for the interests of their peoples, and as native rulers exist within their territories, a Protectorate has seemed the most obvious type of government to set up. Kenya, Nauru and Palestine are the only exceptions—Kenya, because of the suitability for white settlement, is partly a colony and partly a Protectorate, the line being drawn where the settlement zone ends. Nauru, on the other hand, a phosphate island in the Pacific, jointly governed by Australia and New Zealand, is too small and sparsely populated to be classified except as a Dependency, while Palestine possesses no great territorial chieftains, the Arabs are mostly of nomadic habits, and, moreover, demands a strong British hand to keep the peace between the Arabs and the Jews, immigrant or original.

On the edge of a Protectorate—sometimes not quite within the legally defined borders of the Empire are sometimes found native rulers whom it is our policy to propitiate by annual subsidies or by occasional gifts in order to retain our influence on a critical frontier. Such spheres are bound to exist on our African hinterland, and we have, since the War, created two more in the Hedjaz and in Nejd on the Arabian Peninsula. The reason for this attitude is obvious; if we are to surrender Egypt and yet maintain our route to the East intact we must avoid all possibility of a jumping-off ground for hostile attack in the Indian Ocean and maintain its inviolability as a British lake. Friendship in such a case is none too cheaply bought.

Our estimate of the Empire is almost finished, but it would be incomplete without some appreciation of the constitutional position of Rhodesia and British North Borneo, of Gibraltar and Aden and Ascension, and, lastly, of the New Hebrides.

Rhodesia and British North Borneo are the last of our British possessions to own the sway of a Chartered Company. The names of the Hudson Bay Company and of "John Company" recall much that is glorious and inspiring in our Imperial History. Many a country "where the pavement ends" would not to-day be British but for the enterprise and courage of pioneers who traded before the flag.

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Only the British North Borneo Company and the British South African Company remain, and the southern portion of Rhodesia is on the point of becoming a Crown Colony or of throwing in her lot with the provinces of the South African Union.[1]

It is patent that a private firm cannot borrow for the necessary development of a new country on the same security as a Government with the backing of the Empire. The heavy Nigerian loan of 1921 is proof of this, and with limited capital ensues restriction of trade and commerce. A dependency under a Chartered Company stands to lose in competition with the Crown colony of the normal type, and it is probable that both Borneo and Northern Rhodesia may also in time advance a step further in the political sense.

Of Gibraltar, Aden and Ascension little need be said. The two former guard the entrance and exit respectively of the greatest maritime defile in the world and protect our great sea route to the East. They are small but vitally important. Gibraltar is a purely military fortress under the jurisdiction of the War Office ; Aden and its hinterland, the entrepôt of trade between East and West is at present subject to the jurisdiction of the Bombay Government of India ; Ascension, on the other hand, an essential coaling-station, is regarded as a ship at sea and is controlled by the Admiralty.

New Hebrides—jointly administered by French and British—may conclude an homeric catalogue of the component parts of our Weltreich, bound as was said at the outset—by no formal tie.

But there are compensations in the looseness of the chain. The human link counts for more. Loyalty to the Crown—as the flag to the other great possessions of the Anglo-Saxon race—common goodwill—willingness to bear the white man's burden[2] play their part. But, above all, perhaps, is that unconscious pride in the conquest of disorder, the unspoken sense of what is true, the application to land and peoples of practical commonsense.

It is this practical good sense that handles the diversity of the Empire to co-operation and partnership, to life in its fullest vigour.

[1] The Union has agreed to give Southern Rhodesia the fullest possible measure of self-government as well as the necessary financial guarantees. (*Reuter's* telegram in daily papers of July 25th, 1922.)

[2] " In these days the power and majesty of Empire do not make the old appeal to men's hearts and emotions. The things written deeply in the history of Britain that we most value are the love of truth, the tradition that a man must keep his word, the obligation that a nation must keep its engagements. Nowhere in modern British history has Britain betrayed an ally or treated a foe ungenerously or provoked war among the nations. There is great civil, Christian value in such a tradition, and it is of high consequence to the world, and particularly to weaker nations and unenfranchised peoples, that such an Empire should endure."

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BOMBS FOUND IN BELFAST.

By CAPT. E. T. GRAHAM CARTER, R.E.

SOME details of bombs found recently in Belfast, and of one in particular on which considerable ingenuity had been expended, may be of interest to the readers of the *R.E. Journal.*

It appears that at about 7 a.m. one Monday, two men, who were taken for telephone linemen, as they were " complete with handcart and canvas shelter and screens," started work at a large junction-box in Arthur Square. After a short time they replaced the manhole cover, remarked to a nearby constable that they would be back soon with some other tools, and walked away, taking the loaded handcart with them.

At about 8 a.m. some real telephone linemen arrived to resume work which had been left on the previous Friday. They removed the cover and saw lying among the cables a large package covered with sacking and raised the alarm of—" a bomb ! "

The police thereupon requested the attendance of the Sappers for the purpose of removing the object, and an inspection was made. The Fire Brigade was instructed to flood the manhole, and, after about three hours' soaking, the package and sacking were abstracted. Great care was taken in removing the sacking, as a " booby trap " was possible. Nothing, however, happened except to show that the contents were a large box with a small sliding switch on the outside. The leads to this were cut and the box opened. It contained a petrol-tin, a cheap American clock, a Ford coil, and a 4-volt " Ever-ready " dry battery (*see Photo* and wiring *Diagram.* In the *Photo* the clock has slipped from its original position). A small contact-plate

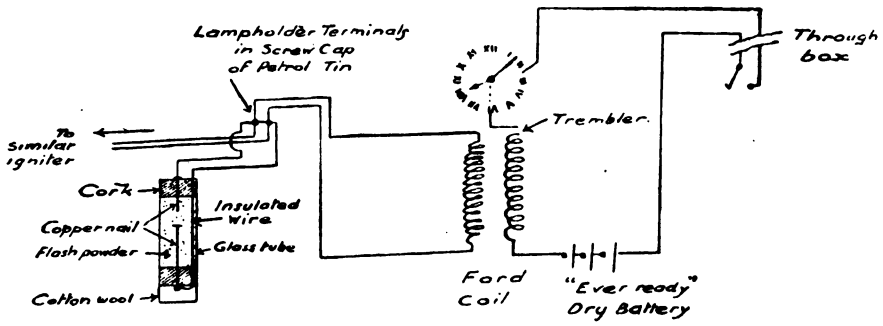

Plate I.

had been soldered to the minute-hand and would have touched a contact-plate on the inside of the box before the discovery was made had the clock not stopped ; and the reason for the clock stopping was that the layer of the bomb had forgotten to wind it ! (This somewhat humorous aspect of the case was not realized until later,

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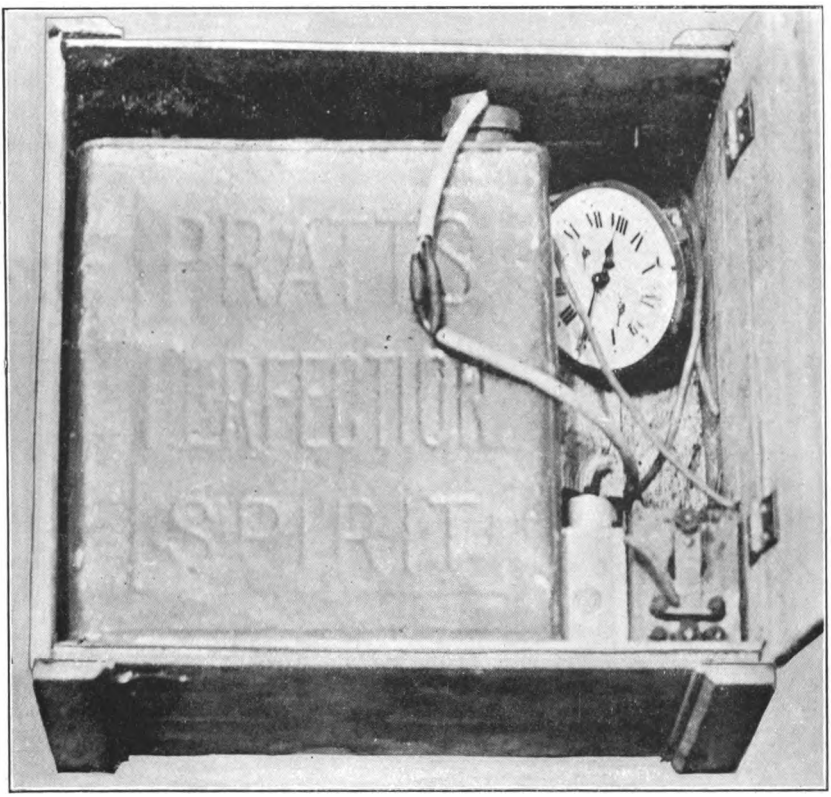

Plate II.

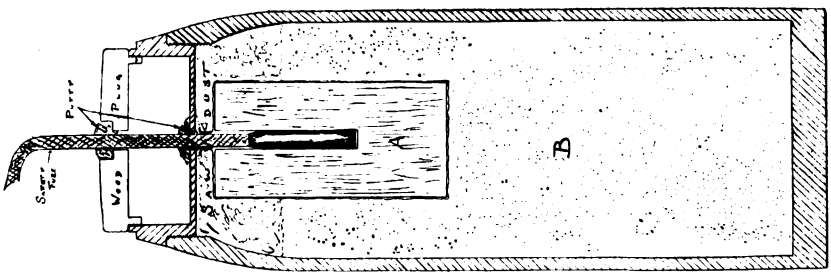

Plate III.

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when an investigation of the " possible causes of the clock stopping " was made.)

We dismantled the machine at our leisure, and, as neither the construction nor nature of the contents of the petrol-tin were known, it may be imagined that that part of the investigation was undertaken delicately.

The leads led through a screw cap, inside which was soldered an ordinary B.C. lampholder. Unscrewing the cap (has anyone noticed what a number of " one-eighths of a turn " there are before a fully-screwed-home cap comes off ?) did not help matters, as the leads disappeared into a mass of what appeared to be sand. A small cap covering a filling-hole, about 1 in. in diameter, in the base was then removed, and a small quantity (about 1 lb.) of sawdust and a dry greyish-brown powder ran out (or was coaxed out with a pencil) together with a few live rounds of ammunition of varying calibre. As a tin-opener makes no impression on a petrol-tin—and a hammer and chisel were vetoed on account of possible detonators—the can was emptied by the tedious process of scooping with a long gouge. When the " detonators " could be freed, they were removed and the remainder of the can's contents were shaken out. They consisted of about 20 lbs. of " explosive " and 5 lbs. of ballast in the form of live rounds and scrap, mostly the former. The major portion of this explosive was damp, as the screw-cap of the can leaked—bubbles were seen in the manhole during the soak—but an experiment proved that the dry portion would have ignited it none the less. The dry stuff lit easily with a match.

The " detonators," which turned out to be " igniters," consisted of two small glass tubes sealed and bound with insulating-tape and merely contained two copper electrodes (made by cutting a 2-in. copper nail in half) immersed in a magnesium type flash-powder. One was quite dry, the other had got damp, but dried off and was used later.

The impression was therefore formed while dismantling, that the bomb was primarily incendiary (however, *see* below) and was intended to melt and burn all the cables in the box with a view to dislocating the telephone service. Some 1,000 lines—including, I understand, most of the fire brigade lines—pass through that box ; little imagination is needed, therefore, to gauge the " general idea " of the incendiaries.

When the " explosive " was dry, a bomb was made up on the lines of the original, but containing no ammunition, and fired by its own flash-powder in conjunction with a No. 14 fuze. It was highly incendiary, burnt with an intense violet flame, and gave off thick clouds of white smoke. Sodium chlorate and sulphur formed the main constituents, it is thought.

A further bomb was made by filling a pint Bass bottle with the

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powder and inserting a commercial cap and fuze taken from another bomb. The bottle was sunk flush in the ground and the resulting crater was similar to that of an 18-pounder H.E. shell, 2 ft. diameter, and 2 ft. deep; and with blackened sides (*i.e.*, really effective detonation of the "explosive").

In this crater was placed an open tin with a quantity of powder and most of the live rounds mentioned. The mixture was lit and burnt fiercely until the rounds warmed up, when their caps detonated and so detonated the whole, although unenclosed.

It will thus be seen that considerable damage to Arthur Square was intended, as 20 lbs. or so of explosive would have made a fair-sized crater, and the road is pavé.

Old 18-pounder shells are another favourite type of container, and these have been mostly used in picture-houses. (A *Diagram* of the usual filling is attached. "A" is the usual powder, but finely divided and compressed on the lines of a gun-cotton primer and about twice the size. "B" is the usual coarse powder). For various reasons, "wind up" being the most likely, whoever laid them was not always successful in lighting the fuze; four "duds" in as many days finding their way into our "dump" at one period. On the other side of the picture is the fact that the general populace was on such tenterhooks that on one occasion an officer was summoned to a cinema to remove a much-soaked "bomb," which proved to be an empty film box that a careless operator had left outside the projection-room door.

What could only be described as a "mine" rather than a bomb, was found under a pile of timber against a wall on the other side of which was a garage petrol store. It consisted of a 5-gallon oil drum filled with concrete, with a 10-lb. paint drum embedded in it concentrically. The latter was filled with the same old explosive, and a commercial cap and safety fuze completed the business. The fuze was protected by a length of brass curtain-rod and passed through a hole in the lid, which was about 2 in. below the top of the large drum. The whole had been cemented over, leaving a dome about 2 in. high from which the curtain rod protruded very slightly.

Another type of "land-mine" recently found near Armagh consisted of hollow concrete blocks, 9 in. by 9 in. by 9 in., "reinforced" by scrap, the walls being about 2 in. thick.

These could either be sunk flush in the road, or left on the side, where they would resemble marking-stones. They would be fired electrically, hold a charge of about 5 lbs. of explosive, and would have an effective range of about 300 yards.

"Ours *is* a nice 'ouse, ours is!"

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AN OUTLINE OF THE EGYPTIAN AND PALESTINE CAMPAIGNS, 1914—1918.

By MAJOR-GENERAL SIR M. G. E. BOWMAN-MANIFOLD, K.B.E., C.B., C.M.G., D.S.O., *p.s.c.*

(*Continued*).

CHAPTER VII.

THE PURSUIT ACROSS PHILISTIA AND THROUGH THE JUDEAN HILLS. BATTLE OF NEBI SAMWIL. CAPTURE AND DEFENCE OF JERUSALEM.—Description of the Plain of Philistia—Orders to the Desert Mounted Corps—Pursuit by the XXIst Corps—The Battle for Junction Station—Action of 6th Mounted Brigade at El Mughar—Separation of VIIth and VIIIth Turkish Armies—First advance on Jerusalem—Battle of Nebi Samwil—Second advance and occupation of Jerusalem.

THE PURSUIT ACROSS PHILISTIA AND THROUGH THE JUDEAN HILLS. BATTLE OF NEBI SAMWIL. CAPTURE AND DEFENCE OF JERUSALEM.

(*Plates* VI,* VII,* VIII, IX, X.—*Sketch Maps* II and III, El Mughar).

The Plain of Philistia.—The ground now to be traversed by the army, except for the sand dunes fringing the coast, may be compared to Salisbury Plain. The belt passable by all arms was 15 to 18 miles wide to the foothills of the Shepaleh.

The Plain of Philistia is open country—a few cactus hedges are met with near villages—otherwise, the serious obstacles are the large water-courses, all running east to west. (Wadis Hesi, Sukerier, Surar, etc.)

These Wadis have steep banks, and are difficult for vehicles to cross. The soil is very hard when dry, but absorbs water greedily; and after rain quickly becomes a sticky morass impassable for motors, and difficult to march over.

The "former" rains begin in November, and last only a few days. The "latter" rains, and the real winter, set in about mid-December. Torrents of rain fall for three days at a time, then follows a week of fine weather. Cold wind, frost at night. Snow in the hills.

Sir Edmund Allenby's force was using the Turks' metalled road and their light railway for supplies; but lorries were having some trouble, as the "former" rains had begun.

The Pursuit through Palestine.—The pursuit depended less on manœuvre than on supply. The fewer the troops to be maintained beyond railhead, the further they could go. The XXth Corps had for the moment shot its bolt. The transport columns hitherto working for it now had to carry on for the XXIst Corps. The 10th,

* *Plates* VI and VII were published in the *R.E. Journal* for September.

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74th, and later the 60th Divisions were sent back into the Deir el Belah area to refit. The 54th Division was deprived of all its transport, and left in Gaza with a dump of rations to subsist on.

The Desert Mounted Corps, now three divisions again, supported by the 52nd and 75th Divisions, followed up the Turkish VIIIth Army.

On 9th November, at 0800 hours, G.H.Q. sent out the following order to Desert Mounted Corps at Huj, by wireless, and confirmed it by aeroplane.

"O.A.T. 245. 9. AAA.

Press on by shortest route with all available forces to TINE-BEIT DURAS. AAA. 60th Division will remain at HUJ and revert to command of XXth Corps. AAA. XXIst Corps will get troops forward towards JULIS-MEJDEL in support, and form pivot of manœuvre for you as soon as they can. AAA. Meanwhile press enemy relentlessly.—G.H.Q."

The Desert Mounted Corps' objectives, on this order, were as follows :—

Australian Mounted Division, E. Tine-Kustine, inclusive, and to reconnoitre Junction Station ;

Australian and New Zealand Mounted Division, Kustine (exclusive) to Beit Duras, reconnoitre Esdud, and gain touch with XXIst Corps ;

Yeomanry Mounted Division, in Corps Reserve, on the railway east of Faluje ;

D.M.C. Report Centre, to Huleikat. (*Plate* VI).

The Turks in front of General Mott withdrew to Hebron and Daheriyeh, while the 53rd Division concentrated about Beersheba. Indications of a projected Turkish counter-attack, from Hebron against our right, were received on 9th November ; but the VIIth Turkish Army were known to be so disorganized, and to have lost so much transport, that Sir Edmund Allenby disregarded this threat. Except that, the Imperial Camel Corps were moved up to Tel el Nejile in support of the Yeomanry Division. Khamsin weather prevailed for the next two days.

On 11th November, the Yeomanry Mounted Division was diverted from the foothills of the Shepaleh to Mejdel. All three mounted divisions were in action on 11th and 12th November, they advanced some 20 miles and took Esdud and Nahr Sukerier, an important place for landing sea-borne supplies.

The Battle for Junction Station (*Plate* VII).—On 13th November the Turks were standing to face the British on a lightly-entrenched front of 20 miles, from Beit Jibrin to El Kubeibe. Their right was five miles in front of the Ludd–Junction Station railway ; their left was in the foot-hills.

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The position was taken by the Australian and New Zealand, and the Yeomanry, Mounted Divisions which turned the right flank of the Turks, and the 52nd and the 75th Divisions which stormed the centre and seized the Jerusalem railway.

El Mughar. (*Sketch Maps* II and III).—A remarkable cavalry action took place during this battle. The 6th Mounted Brigade were co-operating on the left flank of the 52nd Division, when that formation was checked by a strong Turkish position at El Mughar. About 1230 hours the Bucks, Berks and Dorset Yeomanry, Berks R.H.A. Battery and the 17th Machine-gun Squadron were assembling in the Wadi Jamus, a deep cleft in the plain. Brig.-General Godwin received instructions to take El Mughar, and at once reconnoitred the approaches.

At 1500 hours the Brigade emerged from the *wadi*, and covered by the R.H.A. and its own machine-guns, charged across 3,000 yards of open ground, through a zone of machine-gun and artillery-fire, on to the Turkish infantry. The Bucks and Dorset Yeomanry attacked in columns of squadrons extended to four yards' interval. The Dorset Yeomanry had furthest to go, their horses were exhausted, and one squadron which dismounted suffered severe casualties. The Berkshire Yeomanry mopped up, and their R.H.A. battery fired 200 rounds at 3,200 yards' range in support of the charge. The 6th Mounted Brigade captured two guns, twelve machine-guns, and 1,100 prisoners; and enabled the infantry of the 52nd Division to push home their own attack. The casualties of the brigade were 16 men killed, 113 wounded, and 265 horses killed besides.

The 8th Mounted Brigade meanwhile had galloped into Yebna. Junction Station was occupied at 1700 hours on 14th November; and, next day, the Desert Mounted Corps took Jaffa, Ramleh and Ludd. Another gallant charge occurred on this day at Abu Shusheh, just south of Ramleh, when the Dorset and Bucks Yeomanry rode against a strong rocky position held by 4,000 Turks, of whom 400 were killed in the encounter.

Sir Edmund Allenby had now secured a port for supplies, and a metalled lateral road to bring them along by. Meanwhile, the 54th Division was hurrying up the coast to rejoin its Corps.

The Turks then broke up into two distinct masses, widely separated by the physical formation of the country. The VIIIth Army (XXth and XXIInd Corps, four damaged and one fresh division) retired into the Plain of Sharon behind the Nahr-Auja—a real river. This mass was based on the Afule–Tulkeram railway.

The remnants of the VIIth Army (IIIrd and XVth Corps), of six shattered divisions, and the 3rd Cavalry Division, had only a *cul-de-sac* railway from Jerusalem; and really were based on railhead at Nablus, 50 miles away by road. The only means of cross-com-

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munications between these two masses was through Nablus and Tulkeram, about 75 miles round by road

The Commander-in-Chief decided to contain the VIIIth Turkish Army, to wheel our forces to the right, pivoting on Junction Station, attack the VIIth Army and occupy Jerusalem, but he wished to avoid fighting in or close to the Holy City.

The First Advance on Jerusalem.—Battle of Nebi Samwil.—(*Plate* VIII).—The west side of the Judean ridge consists of a series of spurs, running east and west, separated from one another by narrow precipitous valleys. On the intended line of the British advance was only one real road, the Jaffa-Jerusalem-Jericho railway.

This ancient road traversed east of Latron a narrow defile for four miles. It then zigzagged over the mountains in a succession of hairpin corners, and it had been effectively damaged by the enemy. The other so-called roads were mere goat tracks, up the hillsides, or along the boulder-strewn *wadi* beds, and quite impassable in their existing state for wheeled transport.

The plan of attack was to move the Yeomanry Mounted Division (Major-General Barrow), supported by infantry of 52nd Division, through the Judean Hills, by the tracks, three to five miles north of the main highway, and break out on to the main Jerusalem–Nablus highroad and so to cut off the Turks in Jerusalem. The 75th Division, in the centre, was to seize the Bab el Wad defile, and the 10th Australian Light Horse advanced by the defile further south, through which the railway went up.

The Yeomanry Division moved off on 17th November through Shilta, near Ludd, and reached Beit ur el Tahta on 18th November. The 52nd Division passed Beit Likia on the 19th, and with great efforts, double-horsed and man-handled, took three sections of artillery along with them.

The Yeomanry were held up in front and tried to work round the right of the Turks, who were now being reinforced by the fresh troops of the Yilderim Army diverted from Mesopotamia. On the main road, on 20th November, the 75th Division was strongly opposed by entrenched troops about Saris. The weather broke, and this helped our troops, who, at 1700 hours, stormed the heights of Kuret el Enab, in the fog and mist, and cleared the summit of the pass, 3,000 ft. up. There they bivouaced, in their summer clothing, through a pouring night.

Next day, the 75th Division captured the commanding spur of Nebi Samwil, the furthest point to which Richard Cœur de Lion advanced. This strong eminence overlooks Jerusalem, and is only three miles from the Nablus road. (After this achievement, the 75th Division set up the " Key " as their Divisional sign.) The 52nd Division made progress, but the Yeomanry were in most difficult

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ground. Although heavily opposed, they got nearly to Beitunia and Ram Allah, two miles from the Nablus road. But their mountain artillery was outranged, and the mounted brigades were obliged to relinquish their gains.

On 22nd November, the Turks tried three times, in vain, to retake Nebi Samwil; and, during the next three days, the 52nd and 75th Divisions unsuccessfully tried to advance. The British line was only four or five miles from Jerusalem, which was in sight; but cold and casualties had, for the moment, enabled the Turks to stem the advance. The offensive was suspended until communications could be improved, fresh troops brought up, and supplies and ammunition assured.

The feature to observe in this phase is that the enemy again was given no breathing time. He had been hurried up the plain, hit at hard when he turned to stand; and now he was hustled through the mountains past the ground where, if he had been able to organize his defences, he might have held up the pursuers indefinitely. These narrow passes from the plains have seldom been forced, and have proved fatal to many invaders. But, in one uninterrupted rush, the whole British force had advanced 50 to 60 miles, had secured Jaffa, had divided the Turkish Armies, and was at the gates of Jerusalem.

The Second Advance and Occupation of Jerusalem (*Plate* IX).—On 22nd November, the headquarters, XXth Corps, were set up at Junction Station, and the 10th, 60th and 74th Divisions, fresh and refitted, were all hot-foot across Philistia. The 53rd Division was preparing to move along the Hebron road. The plan for the next move was that the XXth Corps should advance on Jerusalem from the south-west and west.

During the interval of preparation, especially road-making, the Turks delivered several counter-attacks.

On the left of the British, on November 25th, the VIIIth Turkish Army pressed back the thin screen across the Auja, and re-established their line overlooking Jaffa.

On 26th and 27th November, the 52nd and 75th Divisions were being moved over to the coastal plain. Next day, the XXth Corps took over the Jerusalem front and the XXIst Corps the Ludd–Jaffa front.

The Yeomanry, in the right centre, continued to be heavily pressed, until they were relieved by the 74th Division, and went into reserve south of Jaffa.

The pressure of the new attack from the south-west was now developed. On 1st December, General Mott with the 53rd Division began to move on Hebron, and by the 6th December he was four miles south of Bethlehem and in touch with the 10th Australian Light Horse Regiment in Wadi Surar.

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The six weak divisions of Turks were now holding a line covering Bethlehem from the south, then turning to the north across the railway, and along the formidable ridge overlooking the Upper Wadi Surar, then east of Nebi Samwil, and thence bearing north-west towards Nalin.

The British line was: 53rd Division opposite Bethlehem, 60th Division south of the Jaffa–Jerusalem road, 74th Division by Nebi Samwil, 10th Division at Beit Sira; and the Australian Mounted Division filling the space between the XXth and XXIst Corps.

As a preliminary to the main attack from the west, the 179th Brigade, 60th Division, (Brig.-General Edwards) crossed the Wadi Surar on the night 7th–8th December and seized the heights south of Ain Karim.

The main attack began at dawn, in wet weather, and was supported by both heavy and mountain artillery. On the east, the 60th and 74th Divisions captured the heights east of Wadi Surar by 0700 hours. The 60th had afterwards a very difficult task, as the high road was enfiladed from the north by formidable entrenchments. The 74th Division took Beit Iksa, but also were strongly opposed. The 53rd passed Beit Jala by Bethlehem. At nightfall the attack was suspended, and the British line was consolidated. The Turks now were fighting on a line parallel to and close to their line of supply and retreat, the Nablus road.

On Sunday morning, 9th December, the Worcester Yeomanry crossed the front of the 53rd Division, and got astride the Jerusalem–Jericho road, closing that exit to the Turks. By 0830 hours, the 53rd Division were within two and a half miles of Jerusalem; and at that moment the Mayor with a flag of truce was meeting the advanced troops of the 60th Division to arrange for the surrender of the city.

During the night, the Turks had evacuated the city, and retired about three miles north-east, astride of and along the Nablus road. It was intended to remove the civilian population, but they could not do this in the time.

The 60th and 74th Divisions were now wheeled to the north, pivotted on Nebi Samwil; and on 9th December they cleared the Nablus road north of Tel el Ful and Shafat, while the 53rd Division occupied the Mount of Olives, and all high ground east of it from which the Turks could observe Jerusalem.

Sir Edmund Allenby made his official entry into Jerusalem on 11th December.

For the next ten days the XXth Corps were busy consolidating positions, improving communications, and accumulating supplies. The coastal area again became the centre of interest.

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CHAPTER VIII.

THE CROSSING OF THE AUJA RIVER; 20th to 22nd DECEMBER, 1917.—Description of the country north and east of Jaffa—Plan for forcing the crossing and its execution —The Turkish attempt to retake Jerusalem—Observations on the operations, Beersheba–Jerusalem.

THE CROSSING OF THE AUJA RIVER.

THE presence of the Turks on the high ground near the coast, north of the Auja, and at Bald Hill and Mulebbis south of it, and further east, rendered Jaffa insecure for shipping and threatened the one lateral road, Jaffa–Ramleh–Latron–Jerusalem. The XXIst Corps were directed to drive the Turks north and to occupy the line Rantieh–El Jelil. (See *Sketch Map* IV).

The river Auja was from 40 to 60 yards wide, averaged 10 ft. deep, with few fords, it ran at about three miles per hour, and was subject to heavy floods in the winter rains. In winter, the river was fordable only at the bar formed just where it enters to sea, and there the depth was about 3 ft. 6 in. The Turks had an entrenched post to cover this ford, and also kept it under frequent bursts of machine-gun fire at night. The Jaffa–Tulkeram road crossed the Auja at Hadrah by a stone bridge, which also was a mill dam; but the Turks had blown this in. East of Stone Bridge, the ground on the south and left bank was marshy. Generally, the banks of the river were low and muddy, but small groves and belts of trees between Stone Bridge and Jerisheh afforded some cover on both banks. The Nahr Burdieh joined the Auja just below Sheikh Muannis. A belt of sand dunes ran up the coast and, from Tel el Rekkit, low cliffs extended northwards.

Inland, north of the Auja, the country consisted of a downland of sandy hills, with a little cultivation west of Sheikh Muannis. South of the river, there were low grassy hills, thin scrub and some orange groves. Besides Mulebbis, on the left bank, the Turks had a strong position at Sheikh Muannis situated on a ridge, about half a mile north of the river and one and a half miles inland.

The forcing of a passage was entrusted to the 52nd Lowland Division (Major-General John Hill). The river front was carefully examined. A particularly bold reconnaissance was made by two officers who swam out to sea, landed on the Turkish side, came back through their lines undetected, and plumbed the ford as they came.

General Hill proposed to effect the passage by night, and by surprise, without any particular artillery support until after the crossings had been secured. After that, his plan was to proceed covered by a barrage worked to a time-table. But, in order to lull the enemy into a false security, he was to be put under a drill, as

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regards artillery-fire, and to be given a regular dose of night bombardment each evening; so that, when the real attack came, there would be no abnormal artillery action to alarm him.

Broadly, the plan was to take across a small covering force, if possible undetected; then to pass the three brigades over at three points (the Ford, below Muannis, and at Stone Bridge), and also to demonstrate further east in order to confuse the Turks. The navy were to cover the left flank, and harass the Turks near the coast.

Subsequently, the Turks were to be pressed back until beyond range of Jaffa; and the 54th Division on the right also were to move northwards.

The covering troops were to cross first, at point X, on rafts made up from 2,300-gallon canvas tanks. Each raft carried 16 men. Then light bridges were to be put across on piers of similar rafts, to take infantry and pack animals. Subsequently, pontoon and barrel-pier bridges were to be built, and the Stone Bridge repaired. Timber was obtained by pulling down houses and sheds. A pontoon bridge was sent up from the Suez Canal. The rafts were put together under the trees in the German Colony of Sarona. The infantry practised embarking and disembarking in a large irrigation tank at night, and also rehearsed cutting through cactus hedges in the dark.

The operation was fixed to begin on the evening of December 20th, at 2000 hours.

The first troops to cross were to be the 1/7th Highland Light Infantry battalion of 157th Brigade, and its task was to swing left and take the Turkish trenches guarding the Ford at the river mouth. It was to be followed by one battalion 156th Brigade which was to move simultaneously on B (Slag Heap Farm), while a company was told off to bomb the stone wall at C. It was hoped that the enemy would be confused, and would wait to clear up the situation before launching a counter-attack, which would then be too late. Two other battalions of 156th Brigade were to take Muannis, and roll up the trenches at D, respectively. The rest of 157th Brigade were to cross at the ford and move on Tel el Rekkit. The 155th Brigade were to demonstrate at G, and later in the night, cross at H and secure Hadrah and the Stone Bridge.

The 19th and 20th December were very wet days. The Auja rose alarmingly, the valley became water-logged, and the approaches to the crossing place (at X) were so soft that at the last moment 200 yards of corduroy road had to be laid to enable the rafts to be taken to the river. There was a young quarter moon, the night was uncomfortably light, very cold and sounds travelled amazingly.

The intercommunication was very complete, and cables from Divisional Headquarters to brigades and to the artillery were all duplicated.

The operations commenced to time, and in six minutes four rafts

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were afloat at X; half an hour later, half the covering party were across undetected, and the leading pontoon raft was at the water's edge by 2035 hours.

By 2200 hours the light bridges were three-quarters completed, the second battalion was crossing, but the bridging parties were experiencing difficulty with the current and soft banks, and in getting the last bay into place. All times were now put back half an hour. By 2230 hours, two battalions were across, and still all was quiet.

At 2300 hours the first bridge was across and in use. By midnight the whole of 156th Brigade was across, and by dawn they had secured their objectives and were well dug in.

The assault started at 0025 hours on 21st December. The 7th Highland Light Infantry completely surprised the Turks and took the trenches for 1,000 yards north of the ford.

The 1/4th Royal Scots took Slag Heap Farm.

The 1/7th Royal Scots took Sheikh Muannis by 0300 hours.

The 8th Scottish Rifles cleared the ground at D, south of Muannis.

The 1st Scottish Rifles (brigade reserve) put the long wall, C, into a state of defence and had formed a dump of 50,000 rounds, S.A.A.

Meanwhile, at 50 minutes after midnight, the remainder of 157th Brigade began to ford the river—the 1/6th Highland Light Infantry leading.

The ford had not been marked by pickets, owing to the river's swollen state, but the Commanding Officer found it, and the battalion crossed, the men in fours with arms linked, while the Royal Engineers put up the pickets as they went. There were 30 casualties from shell-fire. All went according to plan. By 0200 hours the 157th Brigade was across, and they had secured all objectives by 0548 hours and were dug in.

On the right, the 155th Brigade began its demonstration about 2315 hours, and its covering party at H got across unobserved by 2325 hours. This ground was so boggy they could not launch their bridge piers, and so the troops had to ferry over in rafts, and so lost time; and at 0235 hours, they were 30 minutes late in the programme. But, by 0340 hours two battalions were across, two hours later the 5th Royal Scots Fusiliers had taken Hadrah; and after stubborn fighting Stone Bridge was in our hands at 0540 hours.

At 0600 hours, two batteries were ordered to cross the ford, to support 157th Brigade, and the Navy were informed that all objectives had been taken. It seems that the Turks had expected an attack for some days, but when the artillery-fire proved to be the normal evening shelling, they regarded the attack as merely local demonstrations. They considered the only feasible crossing to be at Stone Bridge, and that elsewhere was impossible in the existing state of the river.

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In daylight, the 52nd Division crossed over its divisional artillery—only one howitzer stuck in the ford—and got ready for another bound forward.

The weather cleared. Three light bridges were finished. A heavy pontoon bridge, and a barrel pier bridge (piers floated down the Nahr Burdieh) were commenced. Stone Bridge could not yet be repaired. The Turks kept it constantly under shell-fire.

On 22nd December the N.Z.M.R. Brigade was crossed over. The 157th Brigade took Jelil, and then occupied the high ground at Arsuf. The mounted troops captured Tel el Nuryieh.

That evening, the 54th Division captured Bald Hill, and during the next day, the line of the XXIst Corps was advanced so as to give ten miles clear between Jaffa, and our lateral road, and the Turks.

The Turkish Attempt to retake Jerusalem. 27th to 30th December. (*Plate* X).—The winter had now set in, and the line held by the British was suitable everywhere, except just north of Jerusalem, to which the enemy was still too close. Preparations to push him back to the line Beitin–Nalin, some 12 miles north, were in hand; but on 24th December news from a reliable source came in to the XXth Corps that the Turks intended to attack on Christmas Day, advancing on both sides of the Nablus–Jerusalem road.

All formations were warned, and the arrangements already planned for the advance were to be put in force as soon as the Turks became sufficiently involved.

The Turkish attack was late, but on December 25th the 60th Division captured a prisoner of 1st Division, just arrived at Bireh, who confirmed the news of the impending attack by the 19th, 24th, and 53rd Divisions in front, and the rest of the Turkish XXth Corps operating from the Jericho side.

Early on December 27th the Turks heavily attacked the 53rd and 60th Divisions, and particularly about Tel el Fut. They delivered eight assaults with picked troops. Meanwhile, the 74th and 10th Divisions were directed to advance on the left, towards Beitunia and Ram Allah. This prompt counter-attack disconcerted the Turks, who were being elbowed off the Nablus road. The Turkish attacks were fruitless; their troops were spent, and the XXth Corps (Lieut.-General Sir Philip Chetwode) on 28th December ordered a general advance northwards.

The 53rd, 60th, 74th and 10th Divisions, breaking down the Turks' resistance, gained ground on both sides of the Nablus road, and their final position on 30th December was Beitin–Balua–Deir el Khuddis.

The Turkish attempt to re-enter Jerusalem suffered crushing defeat, notwithstanding the fresh and specially trained troops brought up for it. They were caught exhausted, and the net result

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of their offensive was that the British advanced on a 12-mile front for a depth of six miles on the right, and three miles on their left.

Sir Edmund Allenby's forces now held an admirable position to cover Jerusalem and Jaffa, and the cross-connecting road and railway, while the winter rains forbade any further advance.

In nine weeks of open warfare, the Egyptian Expeditionary Force had advanced its front some 60 miles, and had fought over sandy desert, open plains, marsh, and mountains, and with a climate varying from a Khamsin to a snowstorm.

Observations.—The operations of this campaign, from Beersheba to Jerusalem, brought out almost every principle of war.

All the great stragetical methods were practised :—

Surprise and envelopment—at Beersheba.

Penetration—at Hareira, followed by persistent pursuit.

Separation—after the battle for Junction Station.

Interception, and *Forcing the enemy to form front to a flank*—as on the Nablus road.

Refusing to conform to the enemy's movements—as when von Kressenstein tried to entangle us in the Hebron foothills.

All the familiar maxims, easy to quote, but so difficult to apply, were illustrated in these nine weeks.

Mystify and mislead the enemy.—Effectively done at Beersheba.

Concentrate superior forces at the decisive point.—Carried out at Hareira.

Compel the enemy to expend reserves.—As after Umbrella Hill.

Economise force, and create fresh reserves at every opportunity.—In using only XXIst Corps for pursuit, and re-fitting the XXth Corps to be ready to relieve XXIst when tired.

Hit hard, hit often ; when checked at one point, strike elsewhere.—Exemplified at Gaza, and in the Jerusalem operations, 21st–24th November.

The campaign also illustrates remarkably the influence of geography, physical features, climate and communications, on the course of operations. And these operations also serve to illustrate the great influence which supply and transport have upon a campaign.

And the tactical problems worked out were as varied as the strategy: attacks from trenches, desert marches, river passages, forcing defiles, crossing mountains—all were dealt with. Again, at Beersheba, it was demonstrated how unsafe it is to leave out an isolated detachment within reach of a mobile enemy. While the means of warfare employed covered every imaginable device, nothing seemed missing, ancient or modern, from a camel convoy to a caterpillar, an artillery barrage, or a forced march.

This campaign also brings out the influence of the personality of the Commander. Sir Edmund Allenby was a careful, foreseeing, and

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forceful leader. When he had decided on a course of action, he carried it through. In any contest of will, it was his way that prevailed, as his opponents discovered. In vain Kress von Kressenstein tried at Khuweilfeh to divert him from his main purpose; and later, von Falkenhayn's attempt to stay the retreat by threatening the right from Beit Jibrin was ignored by the British Commander-in-Chief.

Attention has already been directed to the way in which the mounted troops were developed and schooled in Sinai (p. 98); and since then they had achieved a more advanced stage of progress, in really fluid warfare, in Philistia, and in the Judean Hills. This campaign afforded opportunity for the extensive and continuous employment of cavalry in every variety of operation. But it must not be imagined that they alone won the war. The operations of the mounted troops depended on and were supported by the other arms. The campaign teems with instances of such mutual interdependence. In fact, it is probable that these operations will become a classic, for they constitute a nearly ideal instance of the proper use of all the arms in combination, and of cavalry in particular.

CHAPTER IX.

PREPARATIONS FOR AN OFFENSIVE IN THE SPRING OF 1918.—General situation in January, 1918—Circumstances which prevented a continued advance—Features of Central and Northern Palestine—Preliminary operations for the spring offensive—Advance to Jericho and the Dead Sea—Further advances up the Jordan and along the Nablus road—The Raid on Amman—Crossing the Jordan—Turkish attack on Ghoranieh bridgehead—The raid on Es Salt—Effect of these raids in misleading the Turks—Observations on the operations, January to May.

PREPARATIONS FOR AN OFFENSIVE IN THE SPRING OF 1918.

General Situation in January, 1918.—By New Year of 1918, Russia had made a separate peace. The American Army was not yet fully trained, and Germany was preparing a great effort to effect a decision on the Western Front, before the United States could bring their forces into the war. The Turks were reoccupying the Caucasus, but losing ground in Mesopotamia. The Salonica front was stable. Egypt and the Sudan were quiet. (See *Plates* XI. and XII.).

In Palestine, the British line ran from five miles east of Jerusalem northwards to Beitin, then west to Nalin, and thence north-west to the sea-coast near Arsuf, ten miles north of Jaffa. The XXth Corps were on the right, XXIst Corps on the left, and Desert Mounted Corps mostly in rest about Mejdel, Esdud, Yebna. *Plate* XI shows the approximate positions of the British line towards the end of January, in February, and on 21st March. It will be observed how little force the Turks had then beyond the Jordan.

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It might, perhaps, be asked why did not Sir Edmund Allenby go straight on in January, 1918, when he had in front of him a defeated army. One reason was the presence of the Turks in the lower Jordan valley, and in Moab, which will be dealt with further on. But the main factor was supply. The British force had outrun its communications. On 1st January their railway was 15 miles south of Ludd. The Turks had very effectively destroyed the big bridges on the mountain section of the Jaffa-Jerusalem railway; and the problem was how to feed the troops, and a civilian population in Jerusalem itself of some 80,000 souls, by a single road over difficult passes. The season was quite unsuitable for open warfare; and, in fact, it was impracticable to go on until the communications had been put on a sound footing.

Moreover, the further forward the British went now, the more easy they made the task of the Turks who would get nearer to their broad-gauge railhead at Rayak, near Damascus, and to their sources of supply. So the Commander-in-Chief's policy was to consolidate; and then to advance step by step, so as to be in a position to take the offensive later, and destroy the Turkish Armies altogether.

Geographical Features of Central and Northern Palestine, and across the Jordan.—The theatre of operations contained some very marked natural features. East of the Dead Sea and Jordan depression rose the mountains of Moab, from 3,000 to 4,500 ft. high. The approaches to this plateau are very difficult for troops or transport; but these fertile highlands furnished corn to Palestine and Syria, and were traversed by the Hedjaz railway from Damascus, through Deraa and Maan to Medina. North-west of these highlands, and about 100 miles from Jerusalem is the Hauran, or Jebel Druse, also famous for its wheat and barley. All this country is occupied by Arabs, generally owning little allegiance to the Turks. Jebel Ajlun, bordering the Jordan, was particularly notorious for its unruly tribes.

The approaches to the plateau of Moab all go up affluents of the Jordan—the Wadi Nimrin, the Zerka, Wadi el Arab, and the Yarmuk valley are the chief entries. The only practicable road for vehicles from Jericho leads through Es Salt to Amman on the Hedjaz railway, 50 miles from Jerusalem.

The river Jordan, hemmed in between Moab and the hills of Judea and Samaria, falls very rapidly from Lake Tiberias (−685 ft.) to the Dead Sea (−1,292 ft.). The river flows extremely fast, and rises rapidly after heavy rains and floods the banks. The stream is about 120 ft. across in the lower valley. Much of the bank is covered with thicket, passable only at the regular tracks. The chief tributaries on the west are the Wadis Kelt, Auja, Fara from Nablus, and Nahr Jalud through Beisan. The most important crossing-places are the Henu and Hajlah fords, near the Dead Sea, the Ghoranieh Bridge, the Jisr ed

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Damie at the end of the Wadi Fara, and the Jisr Mejamie near the Yarmuk (Jisr=bridge). A rough road traverses the valley northwards on the west bank from Jericho to Beisan, skirting the foothills. The climate of the Jordan valley is oppressive at all times, and in summer the heat is often intense, and malaria is prevalent.

West of the Jordan, the main range of the Judean hills embraces Mount Ephraim and Mount Gerizim, and north of Nablus extends into the mountains of Samaria, terminating in Mount Gilboa. This range is from 2,000 to 3,000 ft. high. The only road for vehicles is the ancient highway to Damascus, through Nablus, Nazareth and Tiberias; and this was only partially metalled. Water sufficient for local needs is found throughout the range. The valleys of Central Palestine are cultivated, and the hillsides often are terraced for olives and vines.

A branch of this main Judean range cuts across Palestine at an angle to it of 120 degrees and ends in Mount Carmel. This branch is from 1,200 to 1,500 ft. high—very rough country, and forms the southern boundary of the great Plain of Esdraelon. This plain is in three parts—the valley of Jezreel, with Beisan on the east; the Plain of Megiddo, opposite Nazareth in the centre; and the Plain of Acre under Mount Carmel on the west.

The Plain of Esdraelon is very fertile, and well-watered by the rivers Jalud and Kishon, but it is notoriously unhealthy and malarial in summer.

On the west, along the coast, lies the Plain of Sharon, famous as a battle ground in the Crusades, but marshy and malarial. This plain is traversed by a partly-metalled road from Jaffa to Tulkeram and Nablus, with a branch road from Tulkeram to Haifa and Acre.

The same sequence of river, mountain and plain continues on the north of the Plain of Esdraelon.

The river Jordan which rises in the southern slopes of Mount Hermon, flows through Lake Hule (+ 7 ft.) into the Lake of Tiberias.

The Galilean Mountains west of the River Jordan are from 3,000 to 4,000 ft. high and merge into the Lebanon range. The Bay of Acre is a fine anchorage; and north of it there is a narrow strip of coastal plain which ends abruptly at Point Nakura, a steep spur of the lower Lebanon. Fair roads exist from Haifa and Acre across the hills to Nazareth, and up the coast to Tyre and Sidon.

Preparations for the Offensive in Spring, 1918. (*Plate* XI).—The enemy's line of communication, the Hedjaz railway, lay only 50 miles east of Jerusalem; and it was an obviously attractive operation to break across on to it. But no such undertaking east of the Jordan could be carried through until the lower Jordan valley and the principal crossings over that river were in British hands. Moreover, it was necessary, in order to secure their right flank, that they should control the crossings, and acquire sufficient space to the north of

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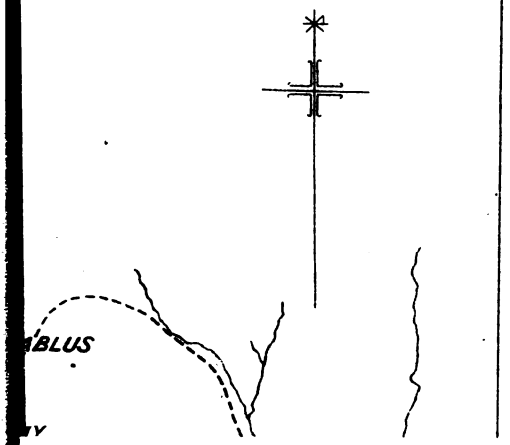
Map Nº 330.

Plate Nº VIII



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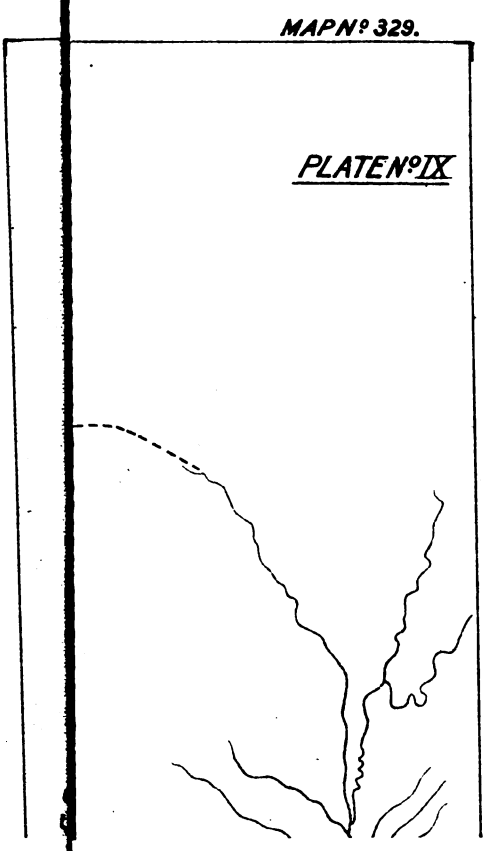

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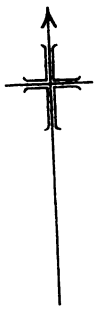

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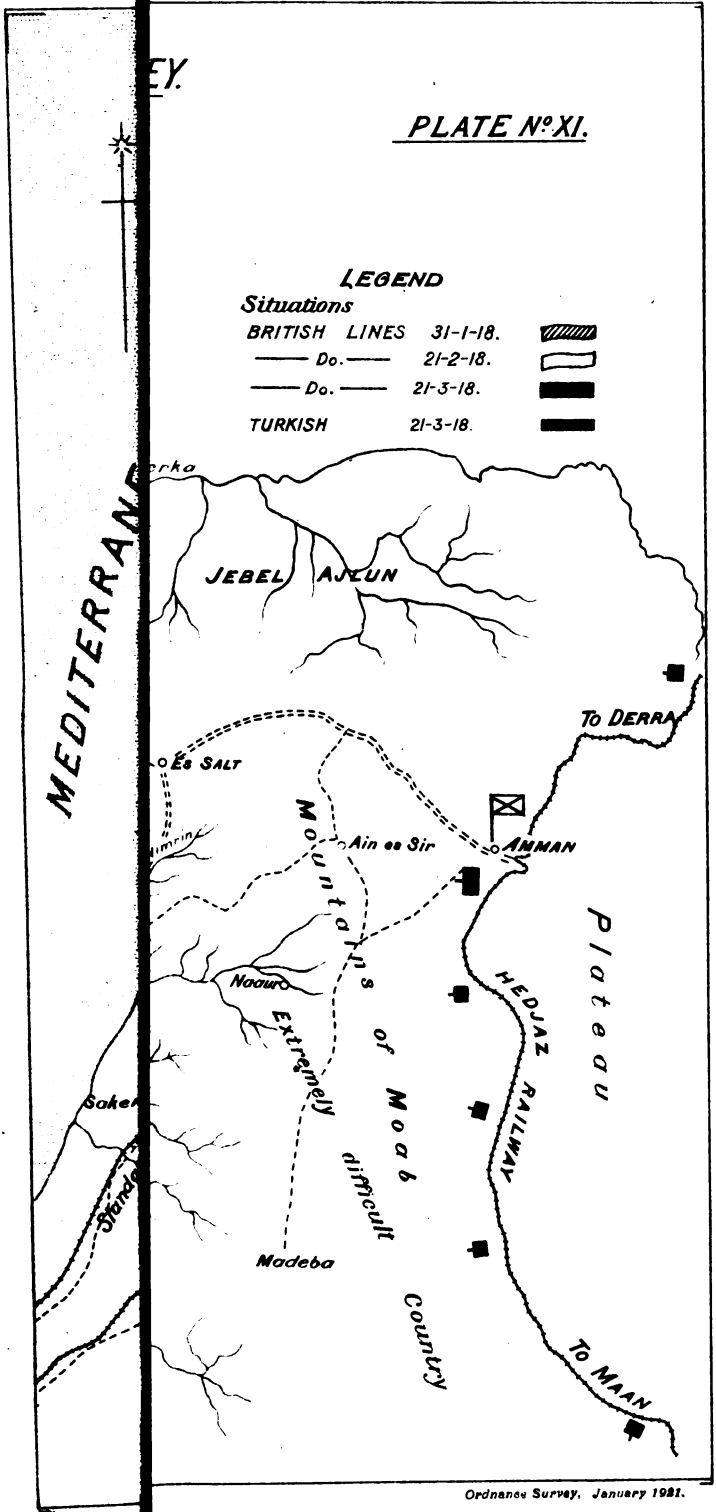
PLATE Nº XI.



Ordnance Survey, January 1921.

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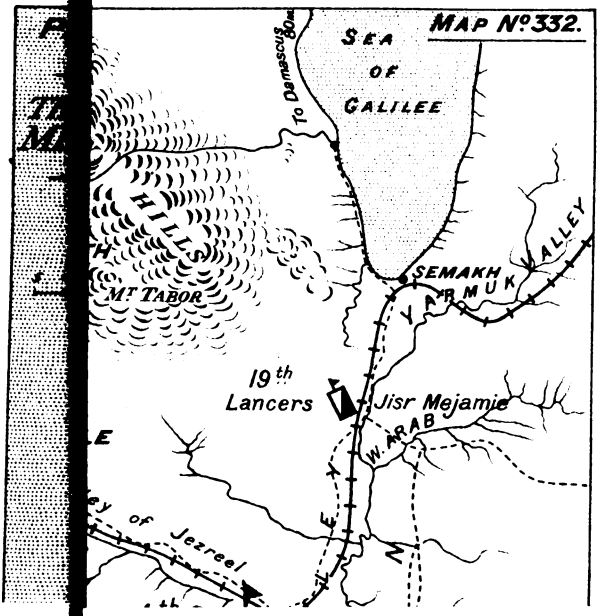

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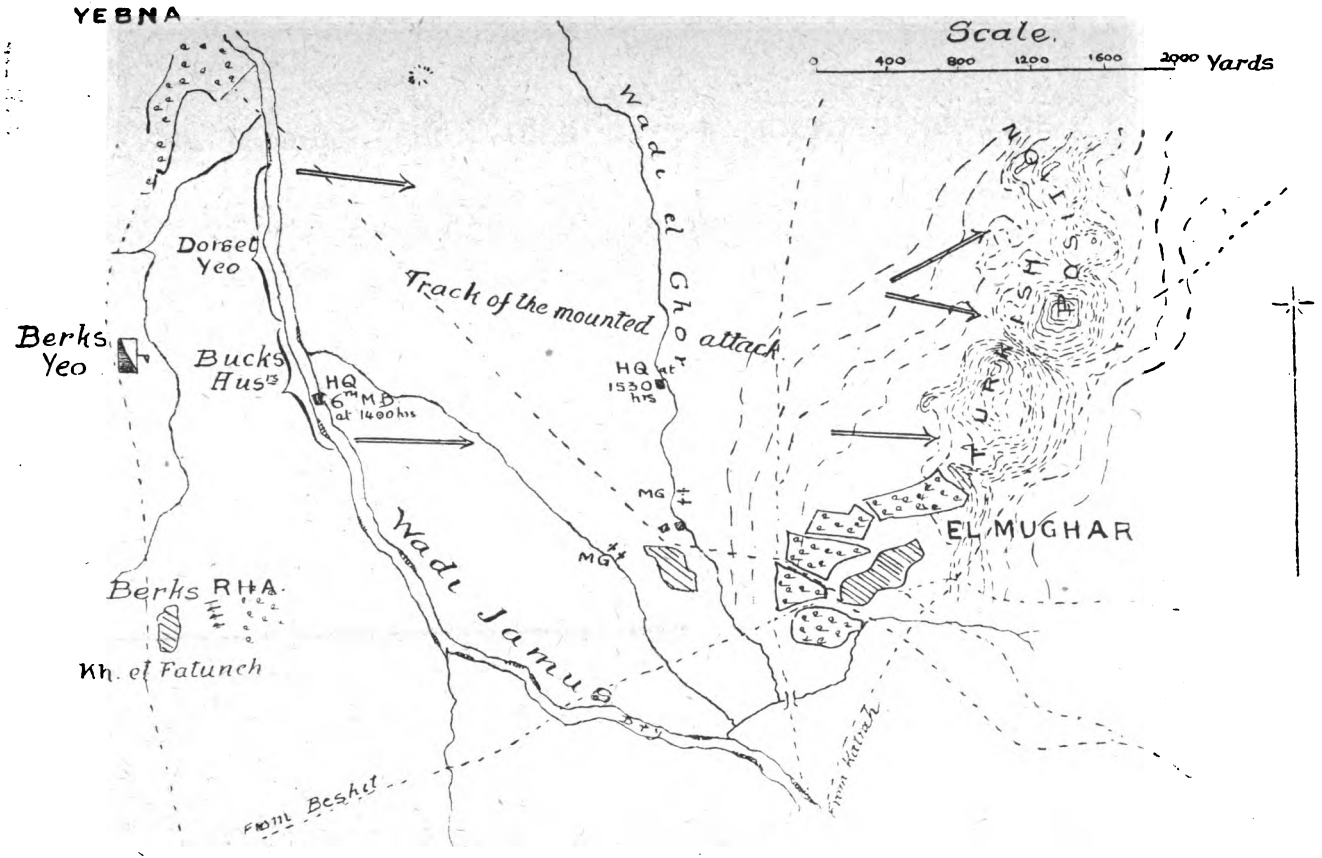

SKETCH II.

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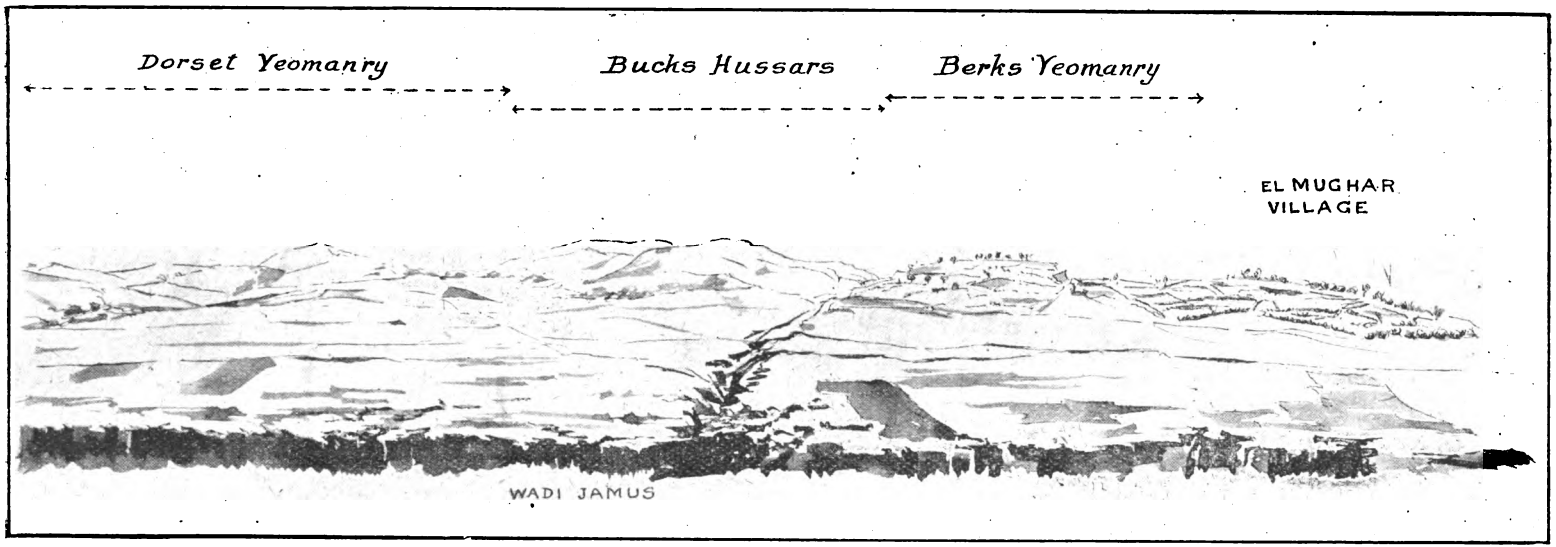
EL MUGHAR. FRONTAGES OF 6th MOUNTED BRIGADE.



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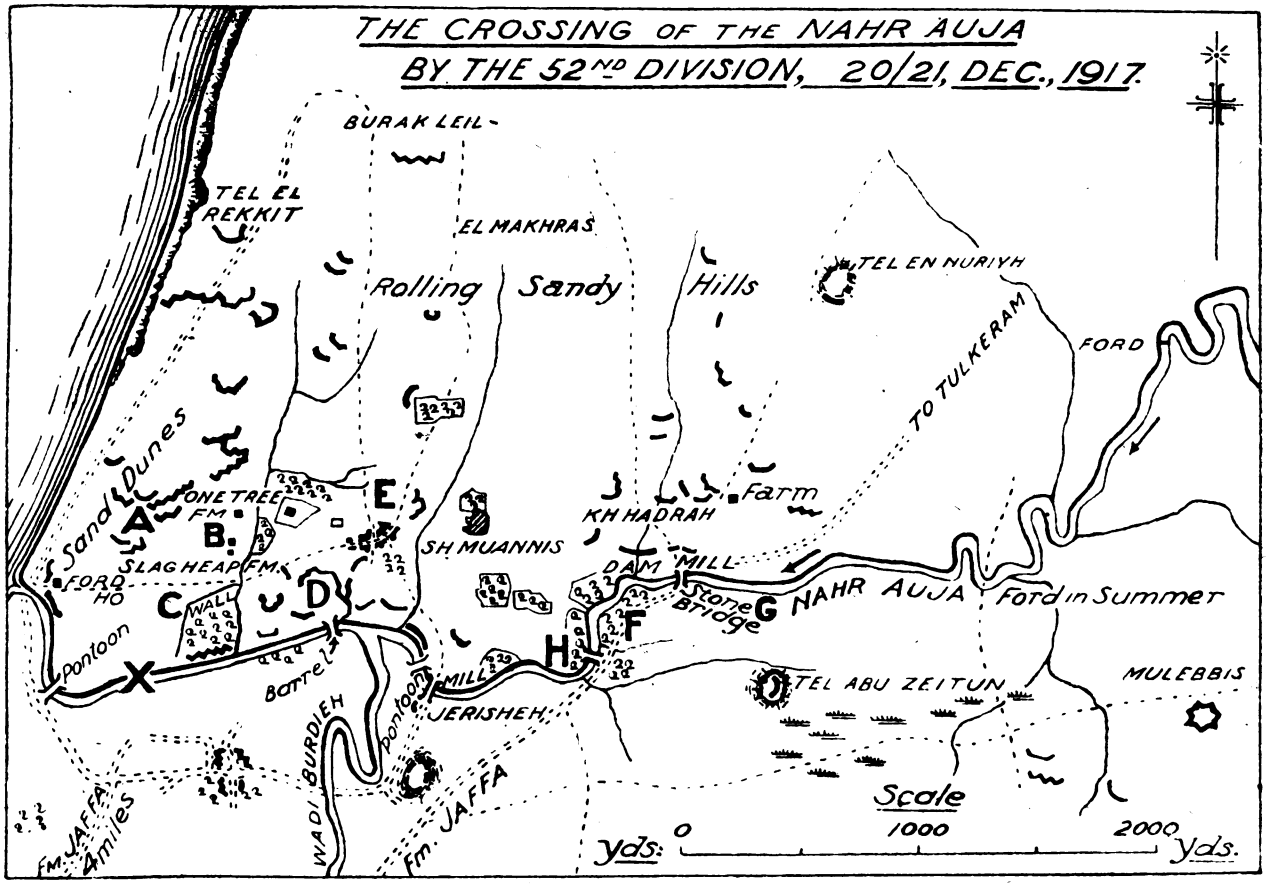

SKETCH IV.

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Jericho to ensure that Jericho, as an advanced base, would be immune from attack.

The Commander-in-Chief decided first to drive back the Turks on his right, take Jericho, and occupy the lower Jordan valley, and, later on, to extend his front northwards.

By securing the crossings over the lower Jordan he would :—

(*a*) Prevent the Turks from raiding west of the Dead Sea ;
(*b*) Gain control of the Dead Sea, and probably secure grain for Jerusalem ;
(*c*) Obtain a good starting point for incursions into Moab ; and to co-operate with Sherif Feisal's army working up the Hedjaz railway.

The limits for the first advance were fixed at the Dead Sea, and west bank of the Jordan up to the entry of the Wadi el Auja, eight miles north of Jericho.

The XXth Turkish Corps, on the right of the British, had about 5,000 rifles available ; but the difficulties of the ground offered greater obstacles than the probable opposition of the enemy. A series of ridges provided strong defensive positions for the enemy, and the precipitous *wadis* running eastwards rendered cross-communication and cohesion between attacking troops very difficult.

Early in February, the 60th Division took over the line east of Jerusalem, and the 53rd Division on its left faced north-east and north. The general plan was for the 60th Division to advance directly as far as the cliffs overlooking Jericho ; while the Australian and New Zealand Mounted Division was to cover their right, enter the Jordan valley near Nebi Musa, and cut off the Turks retreating from Jericho.

On 19th February, the 60th and 53rd Divisions made the first step. El Muntar, eight miles south-east of Jerusalem, was taken and, behind this feature, the mounted troops assembled to operate against the enemy's left. The 53rd Division gained ground commanding the El Taiybe-Jericho track.

During the night 19th–20th February, the 60th Division deployed for the attack of Talaat ed Dumm, and against Jebel Ekteif on the right—about five miles from Jericho. The left on the Wadis Fara and Kelt advanced about four miles. The mounted troops met strong opposition south of Nebi Musa, but found a way round, and by dusk one brigade was in the Plain of Jericho.

In the night the Turks withdrew, and next morning 21st February, the Australian troops entered Jericho and patrols reconnoitred to the Auja, and to Ghoranieh Bridge. The Turks had covered the latter with a bridge-head, and this was not engaged. The 60th Division took up a line on the high ground through Talaat ed Dumm. One mounted regiment was left to patrol the Jordan valley, and the

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remainder of the Australian and New Zealand Mounted Division went back into rest camps.

Although the right flank was now secure, the Commander-in-Chief did not consider the base thus obtained sufficiently broad to permit of operations being carried out east of the Jordan against the Hedjaz railway. It was essential first to cross the Wadi Auja and occupy the high ground on the north bank about Mussalabeh, which covered the approaches to the Jordan valley by the Beisan–Jericho road. Secondly, by advancing further northward, on both sides of the Jerusalem–Nablus road, it was necessary to deny to the enemy the use of all tracks leading to the Lower Jordan valley. When this had been done, the enemy would be able to transfer troops from west to east of the Jordan only after making a big detour to the north.

Accordingly, the XXth Corps were directed to take Abu Tellul, north of the Auja in the Jordan valley, and further west to carry their line to Kefr Malik, the high ground by Sinjil, the ridge north-west of the Wadi el Jib, and so to Nebi Saleh. The XXIst Corps were to advance to the line of old Crusader's castles—Mejdel Yaba and Ras el Ain—and to the northern heights of the Wadi Ballut, which joined into the Wadi el Jib. The two corps would thus move forward their 26-mile front for a maximum depth of seven miles. The ground in the hills was rough and steep, and movements necessarily had to be slow.

The operations began on 8th March, and both corps made progress. The XXth Corps got to the line Nejme–El Taiybe–Sinia–Bir es Zeit, and the XXIst Corps took Abud, a lofty village.

The 60th Division crossed the Auja in the dark, and had stiff fighting to gain Abu Tellul, and to get astride the Jericho–Beisan road.

The 53rd Division took Tel-el-Asur, a very prominent point, while the 74th and 10th Divisions reached the Wadi Nimr and Wadi el Jib. On 11th March, the heights on the far side of these valleys were occupied. The XXIst Corps also completed its task, the 75th and 54th Divisions taking the line of the Wadi Ballut, and Ras el Ain, on 12th March, after severe fighting.

The experience we gained in these operations showed that a rapid advance in the hills was impossible unless unopposed. This was one of the reasons why the Commander-in-Chief chose the coastal area for his main operations in September.

The Raid on Amman.—The situation was now ripe for a raid on the Hedjaz railway. If the British could get on to that railway, the Turks would have to call up troops from the south to help to drive them off; and the forces opposed to Sherif Feisal would be effectively weakened. The particular objectives for a raid were a tunnel and a viaduct near Amman Station; or, failing these, the raiding troops were to do as much general damage as possible to the line elsewhere.

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Amman is 30 miles east by north of Jericho. It is approached from Ghoranieh Bridge by a poorly-metalled and precipitous road up the Wadi Nimrin to Es Salt, a town of 15,000 inhabitants. Es Salt is a road centre for tracks from the Jordan fords at Um es Shert, and Jisr ed Damie, and from the north. The road from Es Salt to Amman was also difficult and in bad repair.

The force allotted to the raid consisted of the 60th Division, the Australian and New Zealand Mounted Division, Imperial Camel Brigade, a mountain artillery brigade, light armoured-car motor brigade, and a heavy battery—all placed under G.O.C. 60th Division (Major-General Shea).

The plan was for the 60th Division to force the crossings over the Jordan. The mounted division and camel brigade, after crossing the Jordan, were to move direct on Amman, demolishing the railway through Naaur and Ain es Sir. After demolishing the railway about Amman, the whole force was to withdraw to bridgeheads on the Jordan. The Turks by this time no longer held any ground on the west bank of the Jordan below the Auja.

The crossing of the Jordan was entrusted to the 18th Brigade (Brig.-Gen. C. F. Watson), supported by the divisional artillery. It was to force its way over at both Hajlah and Ghoranieh, and cover the construction of four or five bridges. Feints were to be made simultaneously at other suitable crossing-places, and a small party in motor-boats were to land on the north shore of the Dead Sea. The rest of the infantry were to cross by pontoon bridges at Ghoranieh, and the mounted troops at Hajlah. The river was high and unfordable, and the stream ran at about eight miles an hour.

The operations commenced early on 21st March, in heavy rain. The flooded Jordan continued to rise, and the attempts at Ghoranieh to cross it in the darkness failed. But at Hajlah, swimmers and rafts got across undetected, and so all efforts were concentrated on Hajlah.

The first bridge was ready by 0810 hours, three battalions were over by noon, and a second bridge was open by 1330 hours. The thicket was so dense that the troops could not extend until next day, when the Auckland Mounted Rifles had got across, and worked round behind Ghoranieh and cleared away the Turks there. By 2200 hours on 23rd March, five bridges were in use, but nearly three days had been spent merely in crossing the swollen river.

Next day the infantry drove the Turks off the Shunet Nimrin position; and, using two roads and with a mounted flank guard, occupied El Salt that night. But the mounted troops, marching directly on Amman in heavy rain, met great difficulties. All wheels had to be sent back. At 0500 hours on 26th March, they reached Es Sir, with animals so exhausted that only small demolition parties could proceed to the railway.

By that evening (26th March), the railway south of Amman

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was being blown up, but the mounted troops were held up in front of Amman, and the Turkish garrison was getting reinforcements. The infantry came up, and Amman was again attacked on 28th and on the night 28th–29th March. But the available artillery was insufficient, and the attacks only penetrated a part of the village.

Meanwhile, the Turks were getting stronger, and the Jordan bridges were causing anxiety as the river had risen nine feet more. Es Salt was threatened from the north. On 30th March at 1730 hours, the troops were ordered back. By the evening of 2nd April, General Shea's force was safely back west of the Jordan, but he kept a bridgehead on the left bank.

This twelve-day raid did not achieve all its objectives, but it had important results. It drew in reinforcements on Amman. The Turks round there increased from 4,000 before the raid to 8,000 just after. It greatly relieved Feisal's situation, and enabled him to become more active in raiding, and in besieging Maan.

The raid alarmed the Turks. They became apprehensive lest a still greater movement from the Jordan should seize Deraa, envelop their left, and cut off their armies in Palestine and Arabia.

The enemy soon realized how inconvenient the British bridgehead on the Jordan would be to them, and on 11th April they attacked simultaneously the Ghoranieh bridgehead and the British front on the Jericho–Beisan road. They got no success and left 500 dead. The enemy then withdrew to the Shunet Nimrin position and proceeded to settle down there.

The Raid on Es Salt.—The Turks at Shunet Nimrin were an isolated force; and at the end of April an opportunity presented itself to cut them off in conjunction with the local Arabs who had offered to assist. The Desert Mounted Corps and part of the 60th Division were employed. On the morning of 30th April the infantry attacked the Shunet Nimrin position in front, while the Australian Mounted Division by a detour north captured Es Salt by 1800 hours. In this move the troops covered 13 miles in 70 minutes.

A mounted brigade was left to watch the flank and stayed astride the Jisr ed Damie road, with patrols to the Zerka and a detachment at Um es Shert.

At 0730 hours on 1st May, this flank brigade was attacked by the 3rd Turkish Cavalry Division, and part of 24th Division, which had crossed during the night at and below Jisr ed Damie. The Turks penetrated between the main body of the brigade and their detachment at Um es Shert. The brigade fell back to the Wadi el Abiad, and lost nine guns in the bad ground. This left the troops in Es Salt only the Um es Shert track for supply or retreat.

Next day a combined attack from the north and south on the Turks at Shunet Nimrin had to be called off, owing to the difficulties of ground and the menace of two battalions, Turkish artillery, and

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cavalry on the north of Es Salt. Besides, the expected Arab support did not materialize, and Shunet Nimrin continued to get supplies. So, again, the evacuation of Es Salt was ordered. A difficult flank march was skilfully executed ; and the raiding force was safely across the Jordan by the evening of 4th May, bringing nearly 1,000 prisoners.

This raid still more convinced the Turks of the danger to Deraa. The idea prevailed that these raids were primarily reconnaissances with a view to main operations later into Moab.

Observations.—The operations in Palestine of the first five months of 1917 afford remarkable examples of the employment of mounted troops in mountainous country, supported by infantry.

In the taking of Jericho, the cavalry were working on the flank of the infantry, and succeeded in getting round behind the enemy, who, when his position was turned, wisely withdrew from the Jericho Plain.

The first raid to Amman illustrates how weather may upset operations, protracting them so that the advantage of surprise is lost. That raid furnishes another instance of forcing a river in the face of an enemy and of following up an advantage—by developing the bridges at Hajlah—rather than lose men in forcibly overcoming the resistance met with at Ghoranieh. This raid also showed how it is possible to reorganize transport, even in the midst of operations. The mounted troops had to extemporize pack-transport, and abandon their wheels, and yet were able to reach their objective as planned.

In the second raid, to Es Salt, the mounted troops again demonstrated the power of the " long arm," able to reach out, snatch an advantage, and rapidly return.

Looked at from the enemy side, both these raids illustrate the danger to which weak detachments—as were the Turks at Amman, Es Salt, and Shunet Nimrin—are exposed when the opponent is mobile and enterprising.

And then these raids show how an enemy may be misled strategically, and encouraged to expect developments from the wrong direction.

(To be continued.)

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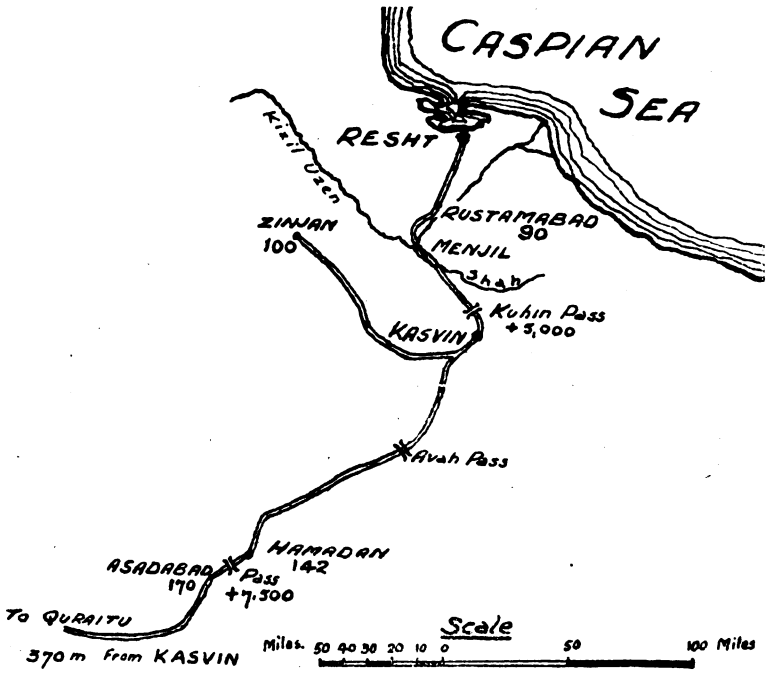
SNOW AND FLOOD IN NORTH-WEST PERSIA.

By CAPTAIN C. F. STOEHR, R.E.

ABOUT Christmas, 1920, orders reached the North Persian Force (generally known as Norperforce) that it was to withdraw to Mesopotamia in the spring, as soon as weather conditions permitted. At this time the force, which originated in the handful of officers and N.C.O.'s who were sent up with General Dunsterville in the hot weather of 1918, consisted of nearly half an Indian division, with headquarters at Kasvin, a strong detachment at Rustamabad facing a Bolshevik force, and another detachment at Zinjan. The L. of C. from the railhead at Quraitu on the frontier was a separate force.



It was decided that the withdrawal should begin at the end of March, but all surplus stores and sick or weaklings were to be gradually evacuated throughout the winter.

Unfortunately the winter of 1920–21 was incomparably more severe than the preceding one. In 1919–20 the first heavy snowfall occurred at Kasvin on February 1st, and it was only on the Aveh and Asadabad passes that the road was blocked by snow, and then rarely for more than a day or two. On a journey to Tabriz during January I found only a few inches of snow for about 40 miles, and

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most of that had disappeared on the return journey a few days later. In 1920–21 the ground at Kasvin was covered with snow from the middle of November, and the whole of the 170 miles from Kasvin to Asadabad, except the eight miles nearest to Kasvin, was blocked by snow, in several places for weeks on end. One convoy of Ford vans took 52 days to reach Kasvin from Hamadan, having waited 32 days at the foot of the Aveh Pass. On this pass there was a cutting in the snow, several hundred yards long, 16 ft. deep and just wide enough to take a car. Throughout the latter half of the winter mechanical transport was practically discarded, north of Hamadan at least, and the preliminary evacuation was carried out by Persian hired transport.

Every effort was made to keep open the road, several thousands of labourers being constantly employed in snow shovelling, but it had not been expected that any such effort would be required, so naturally the supervising establishment was far too small and took some little time to reinforce.

Perhaps the worst piece of the road in some respects, and certainly the worst piece that concerned the Norperforce engineers, was the stretch between 8 and 16 miles south of Kasvin. The great enemy here was the wind, for this stretch was exposed to a strong westerly wind which blew straight across the road from the Kuhin Pass. A regular cycle appeared to set in of snow, frost and wind, still air with perhaps slight thaw, snow, each phase lasting two to four days. The still period, the only one during which much progress could be made, was just about sufficient to clear the road; and regularly, either a day or two after the road had been opened, or before the work was quite finished, more snow or wind came, and the whole thing had to be begun again; it is no wonder that all concerned felt it to be a labour of Sysiphus. On the evening of February 4th, for instance, the road was reported cleared over a width of 15 ft. throughout. The night was cloudless and, in Kasvin, still. Yet next morning the whole of that eight miles was found completely impassable for wheels owing to drifts which had formed during the night. A mile away from where the drifts began the air was warm and still; where the drifts were, a strong and bitterly cold wind was blowing and the air was full of driven snow. Had it been possible to foresee at all what the winter would be like it would have been well worth while to put up snow fences along the eight worst miles near Kasvin, and probably in other places also. The effect of a building a short distance to windward of the road was most remarkable, the road opposite to it being entirely free of snow, while at each end of the clear bit the drifts were several feet deep.

A last great storm occurred about March 20th, and it was not till the 29th that the road was opened for the last time. April in this region is a month of heavy rain-storms which, after gradually

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decreasing in severity, cease during the latter half of May. Sometimes these storms, which are not entirely confined to the spring, are of intense local severity. One of them produced in a small torrent bed, normally dry, which had a culvert three to four feet wide, sufficient water to block up the culvert with boulders, tear away the stone parapets, and to carry across the road and deposit on its outer edge a boulder 6 ft. × 3 ft. × 2 ft. which must have weighed over a ton.

On this occasion the heavy rain and a sudden thaw, acting on the vast quantities of snow still left, caused floods such as none of the inhabitants could remember. The column at Rustamabad, which had been relieved by the Persian Cossack force, began its withdrawal about April 9th, and the first obstacle to overcome was a mountain torrent, only knee-deep, but bringing down boulders the size of a man's head; the whole bed was on the move and was rapidly deepening itself; all transport had to be rushed across this by hand.

A mile below the Menjil Bridge half a mile of the road was under several feet of water, necessitating a new road being cut across the hillside, including a certain amount of blasting. This was done in 24 hours, largely by Indian transport drivers, who, seeing the bridge apparently sitting on the water, put their backs into the digging in a way quite unknown to the ordinary working party.

The Kizil Uzun, which unites with the Shah Rud just above Menjil Bridge, has a very large drainage area, and the flood which came down filled the 420 ft. × 25 ft. of waterway of the bridge right up to the lower boom of the girders, and eroded or scoured out the central pier, 40 ft. × 20 ft. brick and stone in cement, to such an extent that when the troops crossed the bridge the top of the pier was already 2 ft. or more out of line with the others, and ten days later the pier collapsed altogether.

The next obstacle consisted of a boulder some 20 ft. × 10 ft. × 5 ft., which had fallen on the road; fortunately it was resting on one end, so that a minimum amount of work was required to build the road round it.

In two places higher up, where the road had been built up on the foot of a sheer rock cliff, the torrent which ran alongside it had cut away the road till a breadth of little over 6 ft. remained, barely enough to let the transport pass. Had the road been narrowed by another 2 ft. there appeared to be no remedy short of blasting extra breadth out of the cliff, for that torrent in flood was no mean thing. A few miles higher up the road ran for a hundred yards across a mixture of soft rock and earth, where the whole mountain-side, to a height of several hundred feet, was gradually slipping. The torrent here made a sharp bend, and had carried away many protective walls since the road was built; the final experiment made during the previous winter consisted of a diagonal groyne 7 ft. thick and high and about 30ft. long, of boulders in an improvised net of barbed wire;

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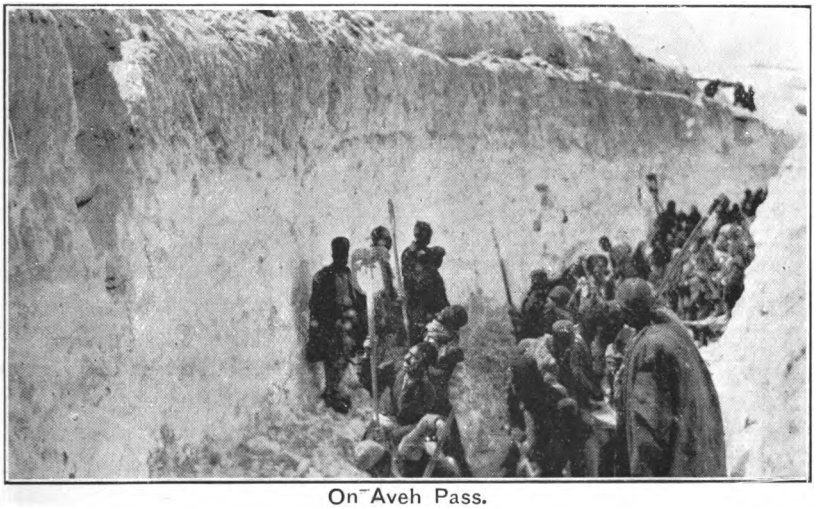
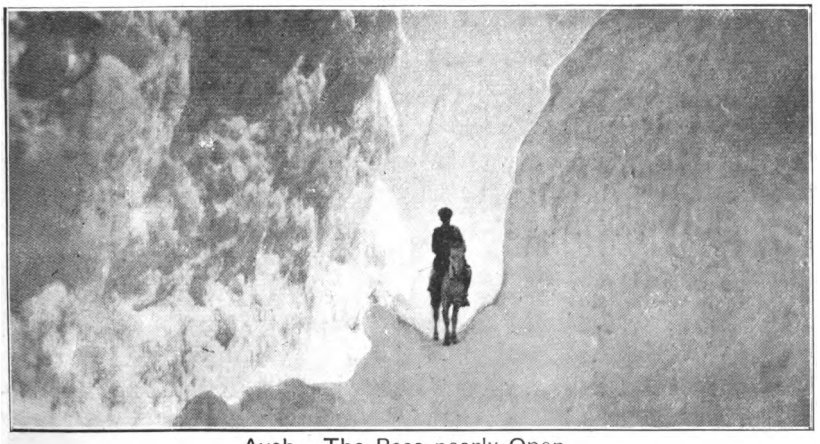
Types of Wash-outs. Result of a Torrent across the Road.



On Aveh Pass.



Aveh. The Pass nearly Open.

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Photos by LIEUT. LAWSON, *Labour Dept.*

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the first big flood swept this away so completely that no trace could be seen. The result was that the road was continually being cut away, necessitating cutting into the hill-side, this in its turn bringing down falls from above which had to be cleared. However, a platoon of sappers and gang of Persians, working in reliefs throughout daylight for several days, managed to have the road open when the column arrived. Between this and Kasvin were no more obstacles except a few torrents across the road, capable of holding up a car but not a column. Meanwhile, we had other troubles at and below Kasvin.

Along the west wall of the town and under a 15-ft. or 20-ft. stone arched bridge runs a torrent bed, dry throughout summer and autumn, and the road to Hamadan runs along the top of its western bank. Down this came, one afternoon, a flood which made the bridge tremble distinctly until the pressure on it was relieved by the water breaking its bank a bit higher up and flooding across the road between the bridge and the junction of the Menjil and Hamadan roads. Quarter of a mile lower down it changed its bed, so that the current set in against the right bank, and by next morning had bitten a hundred yards out of the road in one place and was already biting into it in another ; the flood had lessened sufficiently, however, for protective measures to be taken. Where the road had completely gone a series of diagonal groynes along the former bank of the road nearest to the stream was put down. These groynes were 9 ft. to 15 ft. long and were formed of three to five posts driven well in and faced with corrugated iron sheets, which needed no fastening, as the force of the water held them firmly in position ; they were backed up by brushwood, but experience showed this to be unnecessary. The effect of these groynes was immediate ; within a few minutes of one being made a sandbank had formed behind it, and by next morning the whole area where the road had gone was a mass of dry shingle. The place where the torrent had only begun to eat into the road was protected by a wall of sandbags but probably groynes would have been better.

Thirty miles towards Hamadan the road crosses a shallow valley, which stretches for 40 or 50 miles towards Zinjan. Normally all the water coming down is diverted by a small bank of earth—hardly worthy of being called a dam—four miles above the road, into a canal which runs under the road. A heavy flood burst through the dam and caused a river to cross the road. When we commenced to tackle this job the river was running in two branches, requiring about 60 ft. and 20 ft. of bridge, which had to be strong enough to take loaded three-ton lorries. This meant spans of only 4 ft., and a lot of material, all of which had to be sent from Kasvin. The canal was carrying all the water that it could without endangering the bridge over it, so that no more could be diverted into it by restoring part of the dam. Before the material could be got out,

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however, there was another problem to face. Over the eight miles south of Kasvin, where the snow had been worst, the road was a foot or so above the plain, with culverts to carry off water across the road. These culverts being quite insufficient to carry the floods, the water had banked up and in many places was flowing over the road in sheets a few inches deep and anything up to fifty yards wide. After a couple of days it began to cut ditches across the road from the downstream side, forcing the traffic further and further to the other side and eventually off the road into the flooded fields at the side. The remedy adopted was to cut ditches some 3 ft. wide across the road until there were enough to take all the surplus water, and then revet and bridge them with poplar poles, sacks, and corrugated iron. Eventually seventeen new culverts were required. All this work south of Kasvin required little engineering skill, but much supervision and energy, and some forethought. The work was very urgent, for the final evacuation was delayed at the last moment and the ration question was serious, the reserves having naturally been cut down to vanishing point.

While the most urgent work was being started the torrent across the road just outside Kasvin had much diminished, but was very troublesome to cars and lorries; if a car stuck, the scouring action of the water immediately caused it to start sinking in the sand, and in a few hours it would so bury itself that little but the hood was visible. After some difficulty, due to the water having found its natural channel and trying to retain it, the first day's work being a failure, and that done on the second day being swept away by the flood which the melting of the snow brought down every afternoon, the water was finally put under the bridge again. The method adopted was to drive in pickets on the line of the new bank to be made, put down corrugated iron sheets against the pickets, with filled sacks to stop any rush of water under the sheets, and then back up with shingle.

By the time that this was done the Menjil column had reached Kasvin, the road, with all the new culverts and the ford across the flood thirty miles away, was taking marching echelons with Persian transport, and all that remained was to get the mechanical transport across the latter flood.

By April 23rd the two bridges were finished, and the M.T. began to cross. A convoy of Fords crossed first, then the armoured cars, then the 3-ton lorries began. Between the two bridges was a stretch of 80 yards of dry river-bed, consisting of firm round shingle and sand. The first half of this had been very heavily metalled, but only about 3 in. had been put on the second half, as the foundation appeared so firm. The leading lorry, however, pulled up the thin metalling sufficiently to get through it to the foundation, and then rapidly dug itself in, owing to the round shingle having no coherence,

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despite its hard surface. The leading lorry was helped out and across with ropes, but before they could be stopped two others had crossed the first bridge and were standing on the heavily metalled portion of the road. The leading of these two lorries was loaded with aeroplane engines, in packing cases which were too heavy to man-handle. It was now evening and a heavy storm had started, so further work was postponed till next morning. It would have been impossible to pull the lorries across during the night, for the first lorry of all had gone too near the edge of the improvised road on the far side and had bogged itself, effectually blocking the road.

During the night the river rose a foot, and next morning the two lorries were standing on a small island, with a stream 2 ft. deep between them and either bridge. Nothing could be done that day, but by the following day the water had subsided sufficiently to train part of it back to its former channels and to prepare for bridging the new channel which had formed.

During this day, however, the R.A.F. and M.T. officers decided to try to get the lorries across a ford and to risk their sticking in the river-bed, and on the following day the venture was made. A tender, replaced by the first lorry across, ran backwards and forwards in a hard field on the far side, assisting each lorry across with a long tow-rope. By the late afternoon only four lorries were left, but the water had risen and become too deep for them to use their engines, and one was stuck in the stream, with engines stopped.

Remembering Sir Ian Hamilton's saying that a thousand men can make a 6-in. gun climb like a chamois, every available man, perhaps 200 in all, with all the rope that could be found, were turned on and pulled across the lorry in the water and the next one with unexpected ease. There remained only the two which had been stuck in the river-bed for the last three days, and to enable them to be moved four rafts, each 10 ft. square, had been made up of 4-in. poles, so as to form a movable corduroy road. With the aid of these the more lightly loaded lorry was turned round and moved back to the near bank, where it moved up to the ford and was pulled across. The heavier one was moved up the island to the upper end and pulled over amid great excitement and enthusiasm.

This was the last of the numerous and varied obstacles which the Norperforce sappers had had to overcome during the previous three weeks, and, in fact, the last work that the company did on field service, for four weeks' pleasant marching took us to railhead, *en route*, with nearly every other unit of Norperforce, to India.

It was just three and a half years since the company had landed at Basra, and never once did the men fail to rise to the occasion, however great the effort demanded. The greater the call the harder they seemed to work, and the officer might consider himself fortunate who, throughout his service, never commanded a less willing unit.

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MEMOIR.

COLONEL EDWARD DICKINSON.

ALTHOUGH it was known that Colonel Dickinson had been suffering for some years from heart complaint, the news of his death, which took place somewhat suddenly, but quite peacefully, on the 30th June, came as a great shock to those brother officers who knew him well, and especially to those with whom he was closely associated in the last important work of his career—the Trusteeship of the R.E. Officers' Widows Society. Of this work more will be said presently.

Dickinson was born on the 8th April, 1849, and was, therefore, at the time of his death, in his seventy-fourth year. He joined the "Shop" in February, 1868, and obtained his commission in July, 1870. After the usual two years' course at Chatham he went to Aldershot on appointment to the old Pontoon Troop, which was then one of the mounted units of the Corps, and during his three years' service there he gained some of that knowledge of the Corps organization and equipment which served him in such good stead when, later, he became A.A.G.R.E. From Aldershot he went to Bermuda and Halifax, and, later, to Egypt, where he took part in the Expedition of 1882 (Medal and Bronze Star), and in the Soudan Expedition of 1885 (Actions at Hasheen and Tofrek, two clasps). He was at Aldershot again for seven years—1889-1896—when he still further widened his knowledge of Corps organization and affairs, and then went to Barbados as C.R.E., which appointment he held for nearly three years. In the middle of 1899 he came home to take up the Staff appointment of A.A.G.R.E. at the War Office, and of his services there during nearly three years General Sir William Salmond, who was then D.A.G.R.E., speaks in very appreciative terms. Dickinson's Corps work was completed by nearly four years' service in Ireland, first as Colonel on Staff for R.E., and then as Chief Engineer, retiring from the Service on reaching the age limit on the 8th April, 1906.

On retirement he served on a commission on War Department Lands and Properties, and later did good work in connection with Territorial Force Buildings. In the Great War he was employed on the Billeting Committee during the period September, 1914 to July, 1915 and, amongst other duties, helped in the very important and difficult task of selecting sites for the Divisional Hutments which were built for the accommodation of the New Armies. Later, from December, 1915 to February, 1916 he was engaged on a special mission to St. Lucia.

This is a fine record of valuable work, well and truly done, for

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Colonel Edward Dickinson.

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Dickinson was thorough in everything he undertook, but to the younger generation of officers who did not know him in his earlier days he will be, perhaps, best remembered through the splendid service he rendered to the Corps by his unceasing labours during the last few years in connection with the R.E. Officers' Widows Society, already alluded to above. The War, with its sad roll of young widows and the rapid and unprecedented increase in the rate of Income Tax, had seriously affected the financial stability of the Society, with a resultant burden of anxiety and labour falling mainly upon Dickinson as Senior Trustee. The story of the conversion of the Society into a Company, and its reconstruction upon a sound financial basis, will be fresh in the minds of all, but only those who were closely associated with Dickinson in the steps he took towards this end will ever know the immense labour that fell upon his shoulders and the high ability he brought to bear upon this extraordinarily difficult question. The officers of the Corps owe him a great debt which they can only repay by holding his invaluable services in very kindly and grateful remembrance.

Dickinson, amongst his many useful activities, took very great interest in the R.E. Charitable Fund, and for some years served upon the Committee, only resigning his seat thereon when the removal of his home to the country made it impossible for him to attend the meetings regularly.

Now, in writing a memoir such as this, it is natural that one should consider what are the objects that are to be served thereby. In the first place, it must be an intense gratification to sorrowing relatives and friends to be told how well the one they loved has served his King, his Country and his Corps, and to learn in what high esteem and affection he was held by his brother officers. But there is something more than this. Surely the record of the well-spent life with all its high ideals—the fine character, the spotless reputation, the lovable nature, the kindly courtesy—and all were Dickinson's—should be an inspiration to the young officers of the Corps to follow the example set by him of doing one's best with all one's might and of putting duty first in all things.

A quotation from a letter of sympathy, written to Mrs. Dickinson by Colonel Denis de Vitré, a former subaltern of Dickinson's, will well illustrate all that good influence and good example signify and stand for. He says: "Nothing can efface from my memory the high example he set us young officers of how a pure and high-minded officer should devote himself to his duties."

Dickinson could have desired no nobler tribute to his life's work, and we, who are left behind, might indeed be well content if, in the twilight of life, we could only hope that men will thus speak of us when we are gone.

N.L.

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CORRESPONDENCE.

To the Editor, R.E. JOURNAL.

SIR,

I have read Lieut.-Colonel L. V. Bond's criticism of " The Tactical Theories of Captain Liddell Hart " with considerable interest, and I am glad to think that there is someone who is ready to throw down a challenge on behalf of the fighting soldier, in the face of the military pundits. Sapper " Nobby " Clarke and Subadar Bir Bahadur are old friends of mine, and I am delighted to see someone taking up the cudgels on their behalf. Anyone who has had the good fortune to see the show from a front-line trench knows what the mentality of these men counts for.

At the same time, we must be fair all round. Anyone who has had to teach the young idea knows that it is necessary at first to give them a clear idea, by means of concrete example, of what is right in theory and what is wrong ; otherwise they will probably not grasp the essential articles of their military religion. This can be done quite easily in simple English, without having recourse to any jargon of stock phrases, or any other " flap doodle "—to use Colonel Bond's phrase. I imagine that Captain Liddell Hart, whose articles I must confess I have not read with over much care, has set himself to try and produce some definite examples embodying somebody's theory, with this object in view.

It seems to me, therefore, that Colonel Bond's criticism, which is at present entirely destructive, should be followed up by some enunciation by him of how the true faith in these matters should be set forth to the rising generation.

Destructive criticism is often very amusing to the critic and also to those who are not its objects. Colonel Bond's criticism has afforded me much amusement.

About forty years ago a celebrated R.E. officer wrote a very amusing book to destroy the theory and practice of what he called the " drawing board " military engineer. It was delightful to read ; but I remember that after reading it, as a young second lieutenant, I felt that any military faith I then possessed had been destroyed, and that its destroyer had given me little to replace it. I was rather more in the dark than ever.

I would suggest, therefore, to all critics that this destructive frame of mind should be avoided. It is easy to pull a thing to pieces, but it is a dangerous thing to do, unless you put something better in its place.

Yours faithfully,

G. WALKER, *Colonel.*

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REVIEWS.

LES CHEMINS DE FER FRANÇAIS ET LA GUERRE.

(Second Notice).

THIS treatise, by Colonel le Hénaff and Captain Bornecque, the former Director of Railways at G.Q.G., the latter attached to the 4th (Railway) Section of the General Staff, is a detailed and exhaustive account of the work and achievements of the French railways during the war, and worthy of attentive study by all who are interested in the complex question of transportation under modern conditions during a great continental war.

It begins with the plans worked out in peace-time for mobilization under varying conditions, started in 1868 by Marshal Niel, and more seriously studied after 1870. The 4th Section of the General Staff was charged with this duty, in which it was assisted by Commissions for each Railway Company, with a military and a civil member and technical advisers—under them were sub-commissions for railway lines and stations. There was also a Consultative Commission working with the 4th Section of the G.S., composed of superior officers of the Army, Navy and Railway Companies—and apparently corresponding to our Railway Committee.

On the order for mobilization "Plan No. 17" was put in operation, by which the railways in the sector Maubeuge–Paris–Dijon–Belfort passed under the direct control of the Minister of War. This was in view of a concentration on the German–Luxemburg frontier. According to our authors this mobilization and concentration of armies was accomplished exactly according to schedule and without the slightest hitch. The "Nord" system dispatched 3,121 trains on the 2nd to 4th day of mobilization; the Paris–Lyon–Marseille, 3,262 trains. In all, more than 10,000 trains were in motion for mobilization alone. For the concentration of the mobilized units at the front four separate routes were laid down, so arranged that there should be no crossing of any two lines on the level, and no using of the same lines at any junction. Great importance was attached to the "Regulating Stations" from the time of mobilization to the end of the war—situated at a suitable distance from the front. Behind them no deviation from schedule was allowed to the trains. Beyond them to the front the "Regulating Commission" had absolute power as to the disposal and destination of every train.

The plan is stated to have worked to the minute, and five armies, with 1,200,000 men, 400,000 horses, 80,000 vehicles, were disembarked at their destination by the 18th August, 16th day of mobilization, exactly as predicted.

Besides the movement of these troops, the railways had also to provide for their supplies and munitions, removal of casualties,

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mobilization and concentration of reserves, the food supply of Paris and certain fortresses, and the collection of supplies to replenish the Army Stores.

All this had just been completed at an immense expenditure of effort, when the invasion of Belgium, the arrival of the British Army, the retreat of the left and centre of the allied Armies, the transfer of several Corps from right to left, the evacuation of civilians and depôts from the invaded zone, the removal of Belgian rolling stock and all movable material from the French railways affected, produced a most serious crisis, and a tremendous strain on the railways, particularly the lines of the Nord and Est. The first care was to provide new regulating stations for those wiped out, and then to establish lateral lines for the movement of the Corps from East to West, which resulted in the regrouping of the Armies and the victory of the Marne. That all this was accomplished without a serious breakdown must extort a tribute of admiration for the skill and resource of the superior direction, and the devotion and loyalty of the railway personnel.

After the Marne came the "rush for the sea"—again the Nord and Est bore the brunt of the traffic, in addition to the labour of repairing the damage done to the lines by the retreating Germans, of which the most serious was the destruction of the great bridge of Laversine on the line Paris–Creil, the main communication from Paris to Maubeuge, Lille and Calais. A temporary viaduct, begun 9th October, was finished in 25 days, and a new permanent bridge in reinforced concrete was completed by 31st May, 1915.

The book goes into great detail as to the movements of reinforcements from East to West during the prolonged struggle on the Belgian border, during which the British Army was moved from about Soissons to take its glorious part in the battles of Ypres. For the details and difficulties of these movements, the reader must be referred to the text.

On the establishment of the front of trenches to the sea at Nieuport began the long period of trench warfare, in which the work of the railways settled down to the business of the supply of the Armies of the West with the countless needs of the new warfare, the transport and supply of the Armies of the East, and the conduct of the post and parcel post.

Supply alone became a prodigious charge. Six million combatants, French, Belgian, English, American, with a million horses, with tens of thousands of pieces of artillery of all calibres, required in 1915 65,000 trains, in 1916 84,000, and for the first six months of 1918 45,000. This was reckoned, in 1918, at 1,000 tons, or two trains of 50 vehicles, for each French division, whereas, in 1914, 70 to 140 tons sufficed for a division. The smooth and regular pouring in of such a vast tonnage of material of infinite variety from so many diverse sources, required the utmost care and forethought, in which the "Regulating Stations" played a most important part, while the lines of communication were carefully adjusted to serve the sectors of the front.

The inception of campaigns in the near East involved fresh complications. At first the troops were dispatched by sea, but in 1916 the enemy's submarines made it imperative to cut down the sea passage

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to the shortest possible route. Thus the main body of the Eastern Armies with all their supplies travelled by Modane and Mont Cenis (occasionally by the Riviera) through Italy to the port of Tarentum. The British Armies and their reinforcements and supplies also had to take a similar route, starting from Cherbourg and Havre with all the necessary halting stations for food and rest throughout the length of France and Italy. All this imposed a fresh effort on the French railways, the more embarrassing as it cut right across the direction of the traffic to the Armies of the West.

A chapter is devoted to the conduct of the postal and parcels service, of which the difficulties can be imagined, with the constant shifting of units and individuals, and the necessity for secrecy as to their positions. The solution was a "statistical section" in Paris, working through the paymasters of units. The figures are colossal. Suffice it to say that they equalled daily the whole correspondence circulating in France in time of peace.

A chapter entitled "Les Evacuations" deals with the removal of sick and wounded, and the stream of men going on leave.

For the sick and wounded, at first ordinary troop-trains were used, except seven hospital trains, prepared beforehand. These were insufficient for serious cases, so improvised hospital trains were fitted up, and as improved by experience, found to serve their purpose satis-, factorily. Besides these there were semi-permanent trains fitted up for both sitting and lying cases. The distribution of the cases to the various hospitals required much care and arrangement, but the details of this are more suited for study by the R.A.M. Department. Its importance is shown by the fact that up to the Armistice the number removed was 3,610,000 in 12,000 trains, the numbers varying in average according to the intensity or cessation of battle on the front.

The "leave train" was a new departure in warfare, not previously thought of. It carried with it its own difficulties in the suitable adjustment of trains to destination. It further took up 2,728 carriages which could ill be spared, and, of course, added to the overwhelming strain on the railways, and excessive crowding on the trains of the interior. The Paris–Orleans line alone issued in 1915 nine million leave tickets!

The authors next proceed to study the railways as instruments of manœuvre, carefully worked out in 1912 in a confidential memorandum, divided into strategic movements over long distances of large bodies, and tactical movements of small units for short journeys. The latter never caused any difficulty and were used principally for reliefs, especially on the British front. The former required careful planning as to entraining, detraining, the route to be followed, and the nature of the trains to be employed. But all had to be in readiness in the shortest possible time, with every detail worked out. For this purpose certain "*rames*" (rakes=trains made up, but without engines), varying from 180 to 300, were kept in readiness as near as possible to the Corps in reserve, the course of procedure between the C.-in-C., the Director of Railways and the G.O.C. L. of C. (*Arrière*) was laid down, and the lines of lateral communication (*rocade*) worked out in several sections, and improved as experience dictated to ensure easy and rapid communi-

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cation from flank to flank. It is on these lateral lines and on the Regulating Stations that the French seem mainly to have depended for rapid strategic movements.

The German offensive of March, 1918, although to some extent foreseen and provided against, cut more deeply into the railway system than had been expected, and involved long and devious routes for reinforcements. Perhaps the most serious result of the German push was the loss of the vital junction of Amiens, cutting the main line from the North to Paris and throwing that traffic on lines already congested and inadequate, thus requiring enormous labour in establishing a new through line of double track *via* Beauvais to Paris.

Another demand on the already overburdened French railways was made by the call for reinforcements in Italy, after the catastrophe of the Carso. The book traces the routes by which the British and French troops were sent, there being only two possible lines—by the Mt. Cenis and the Riviera—the latter impeded by a single line from Vintimille to Savona. There was also now and always the necessity of supplying Italy with coal and Switzerland with cereals, while the possibility was even envisaged of having to transport an Army to the latter country in case of an attempt to turn the French right flank by an invasion of Swiss Territory. Much detail is given of the difficulties of the routes, the means adopted to ameliorate them, and the number of trains employed, which amounted in two and a half months to 634 *via* Modane, 770 *via* Nice, and a relief *via* Briançon, with a march by road over the mountains into Italy, of 140 trains.

Our authors next go into the details of the railway plans for the various offensives in Champagne, on the Somme, on the Aisne and in Flanders, with the means adopted to improve the often very inadequate communications for supply and munitions. Another chapter deals with the German attack on Verdun, and the extreme difficulty of reaching that fortress by rail after the loss of the St. Mihiel salient, while the only other main line by St. Ménéhould was partly under enemy fire. Here a metre-gauge railway proved of the utmost value.

The German retreat on the Somme, in March, 1917, produced fresh difficulties and required a fresh effort in reparation and extension of railways, with, as usual, a careful organization of lines of lateral communication (rocade). It enables the authors to make an interesting comparison between the German and French railway organization behind the front line, which ends as follows :—" So thus, no combined plan, few depôts, transhipments (from standard to metre or 60 cm. gauge) lavishly organized in view of the abundance of manual labour. They laid 130 km. of 60 cm. gauge without establishing a united or homogeneous system." It is evidently considered that the French worked on a sounder and more systematic plan. But in this it would appear that they flatter themselves unduly. Since writing the above I have had the advantage of seeing a map of the German and British fronts between Peronne and Arras prepared by the R.C.E. of the 5th Army (Col. Ramsey) from aerial photographs, reconnaissance and spies. This shows a far more complete and systematic network of 60 cm. lines and lines of lateral communication than anything that we or the French

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could boast. There can be little doubt but that the Germans have nothing to learn from their opponents in the use of railways of any gauge.

Next comes a detailed study of the various measures taken to remedy the dislocation caused by the German advances in 1918 towards Amiens, to the Marne, and on Béthune, and even in anticipation of further enemy successes. The lesson of all this is the extreme importance and delicacy of the railway system immediately in rear of great armies in semi-stationary warfare, and the vital importance of the lines of lateral communication to the strategic necessities of the campaign.

But it is not only the lines in immediate touch with the Armies that suffer. Chapter XIII discusses the reaction on the railways of the interior of the transportation crisis. It describes the great intensity of traffic on the systems of the Nord and Est, more than three times the whole traffic of peace-time on a much reduced mileage. The demand for rolling stock was felt to the furthest borders of France, greatly curtailing the general train service. In 1916 the traffic reached—as compared with peace-time—on the State Railway, 146%; on the P.L.M., 149%; on the Orleans, 166%; on the Nord, 200%; while these figures rose still higher in 1917 and 1918. The demand for rolling stock constantly increased. In 1918 the tonnage to be moved demanded 457,426 trucks, but 393,331 only were available, including 35,435 supplied from England. Of engines 15,642 were required, 15,508 (1,035 British) were forthcoming. Of personnel, 402,808 were necessary, but only 345,294 could be counted on, and those, like the material, already almost worn out. Nothing but the most careful organization and the utmost devotion of the personnel could make head against such difficulties.

We now come to the counter-offensive, July–November, 1918, with the re-grouping of the Armies under Marshal Foch and the general advance towards Belgium and Luxembourg. Once more the railways were called on for a supreme effort, not only in shifting, transporting and supplying whole Armies, but also in repairing the devastation wrought by the retreating Germans and in following up as best they could the advancing Armies.

Chapter XV is devoted to a description of the most effective destruction of the railway systems of the Nord and Est, every tunnel, bridge and culvert blown up, the permanent way torn up, the crossings, signalling boxes, stations, water supply, etc., ruined, while retarded mines were sown with diabolical perversity. It also details the measures taken to repair the lines and follow up the Armies.

Chapter XVI, on transport after the Armistice, need hardly detain us. The main duty was the supply of the Armies of Occupation (213 divisions—British, French, Belgian and American), the leave-trains, those for demobilization of the Allied Armies, including an Italian Corps, and the repatriation of prisoners of war, all over greatly increased distances, while the re-establishment of commerical traffic, and the requirements of the devastated provinces had also to be provided for.

We now come to a part of the book devoted to the detail of the British share in transportation, in which at first our Army was entirely dependent on the French railways. The preliminary puzzle was that " one could

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not foresee exactly in which ports, at what date, in what order of battle, or in what numbers would arrive the British Army." How were suitable trains to be made up or placed where needed at such scattered ports? Eventually trains were made up to accommodate—K type, a battalion; U, squadron or R.H.A. battery; R, R.F.A. or ammunition column; S, R.E. and Ambulance; Y, H.Q. or odds and ends—and concentrated at the ports Boulogne, Havre and Rouen. Then came the question: Where was the British Army to concentrate? The French G.Q.G., with the concurrence of our G.H.Q., desired our Army to be brought at once into line with the French in Belgium. The British Government wished it to detrain about Amiens, in order that it might have time for rest and re-organization, even proposing that it should prepare a defensive position there! This obviously did not meet the requirements of a critical moment. On the 12th August a discussion lasting three hours at the War Office, between Lord Kitchener and the British and French General Staffs, at last brought him round to their view, and through him the Cabinet, and the detrainment took place between Hirson and Maubeuge. The number of trains employed, for five divisions of infantry and a Cavalry Corps, being 339 trains carrying 4,480 officers, 115,043 other ranks, 45,623 horses, 5,565 guns and limbers, 1,380 wagons and 2,108 bicycles—the entrainments commencing on 15th August, and being completed with exact punctuality on 27th.

From this moment up to July, 1916, the French railways undertook both the transport and supply of the British Army, including its transfer from the Aisne to the neighbourhood of Ypres, and the movement of our Indian Army from Marseilles to the front "with all the precautions necessary to meet the susceptibilities of race and caste." The arrangements and works necessary to ensure smooth traffic are given in detail, with special notice of the Regulating Stations at Abbeville and Romescamps, the latter a vast installation of which the utility was only recognized by our authorities during the battle of the Somme. Mention is made of the famous Railway Depôt at Audrouicq, one of the few big works undertaken in the early days by our railway troops. "The prelude to the great works undertaken by the British specialists in the course of the next two years."

It is explained that our lack of a large military railway establishment made it at first necessary for the French railways to do our work as well as their own, but that the increase of the British Armies and the stabilization of the front made a change necessary—and a demand for further help on our part. On the other hand, I believe it is well-known that the French were very jealous of any interference on our part with their railways, and we were in a position to give them plenty of assistance before they would admit its necessity, only forced from them by the imminent breakdown of their service in 1916, and the vast railway organization which we created under the direction of Sir Eric Geddes at the end of 1916, and after, might have been provided much earlier had its necessity been realized by both French and British G.H.Q.—while it was long enough before either G.H.Q. realized how much might be done by temporary or light railways to expedite supply and relieve the road transport.

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It is unnecessary to go into the detail of the British railway organization when Sir E. Geddes took it in hand. Suffice it to say that from the end of 1916 we took over and worked the whole railway system supplying our Armies, with our own rolling stock and personnel, and laid the numerous additional lines necessary for the Somme offensive, the various attacks in 1917, the great depôts and magazines for our stores, and the 60 cm. lines that formed a complicated network of supply immediately behind our trenches.

In conclusion it is remarked that "the Army of 1914 arrived without any means of working or constructing railways, either in personnel or material..... The rôle of Regulating Stations, such as we understand it, is played in no way. The French Army undertook all the transport and most of the work till 1916, while urging the British to adopt our methods. As the English effectives increased the British Command began to understand the situation, and when once the decision was taken, its execution was pursued with that application and tenacity which are characteristic of the English nation, and constitute one of the elements of its success."

The next chapter deals with the American transport. Here again was a very serious fresh burden on the French railways. The urgent necessity for getting American troops into France prevented the previous provision of a transport system. At no time up to the Armistice did the American Army provide more than half its railway transport. The geographical exigencies of disembarkation caused the American lines of communication to cut right across those of the French Armies, from the ports of Brest, St. Nazaire, Rochefort and Bordeaux to the whole front between Paris and Nancy. Much personnel was required to instruct and interpret for the American drivers, guards, etc. In November, 1918, the American effectives amounted to 2,500,000 men, requiring 410,000 tons of supplies per month. The American Army was considerably broken up, by the self-sacrifice of its command, to reinforce the Allied Armies at the crisis of the German advance in 1918. All this imposed a traffic of such importance, such intensity, such duration, on four different railway systems already fully crowded and least prepared, as imposed an exceptional effort on the lines affected, and could not be accomplished without delays and accidents. Still, the trains arrived with sufficient regularity, men, arms and supplies were brought where wanted, without any question that the lines of communcation would fail to bring up whatever was needed at the right moment.

A final chapter reviews the whole subject. The general traffic rose 41% on that of 1913, with, on part of the Nord railway, an increase of 200% at times. Up to 11. 11. 18, 100,000 trains transported 60,000,000 men. For supplies were required daily a mean of 80 trains of food, 40 of munitions, 16 of engineer stores, 16 of various material, 16 for maintenance of roads, 25 reinforcements; that is, 200 trains per day, or 300,000 wagons and 550 engines.

To accomplish this much work was required on new lines, doubling single lines, diversions, shunting and depôt yards, repairs, etc., as to which details are given. Praise is adjudged to the unity of direction

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under a central authority which applied the resources of all the railway companies where necessary and assured the co-ordination of effort.

The metre-gauge lines proved useful where they existed. For new lines it was found better to make use of normal gauge.

The vexed question of the 60 cm. gauge, of which little has been said in the preceding chapters, occupies but half a page. It is urged that for a war of position it can render good service. It adapts itself to the ground more readily than broader gauges, with gradients of 25 to 30 mm. and curves of 20 m. radius, but its capacity diminishes rapidly as the slope increases. It requires a numerous personnel, and, contrary to previous belief, very heavy ballasting. In a similar war in future, the main effort should be directed to the formation of units of construction and operation (for broad gauge, which Canadian and American experience in pioneer work shows to be as easily and expeditiously laid and worked with better results).

Finally—the railway is as important in plans of campaign as men, arms or science. An Army deprived of a railway, well organized and worked, would find itself in as critical a situation as if it lacked guns or munitions.

H. M. SINCLAIR.

REINFORCED CONCRETE.

By CAPT. A. F. DAY, R.E. (Published at the School of Military Engineering, Chatham, 1922.)

REINFORCED Concrete is a subject which is full of anomalies. Though based on a very few of the simplest of engineering principles, it embraces an infinity of complicated structural applications. Again, although it is subject to exact mathematical calculations, the numerical results are dependent upon empirical values, the truth of which rests upon quite incalculable human elements.

One effect of this was early to introduce the reinforced concrete specialist, and subsequently to maintain him in his position. In spite of all that has been argued against the practice, it is still customary in civil engineering to entrust both design and execution of important works to specialists. This practice has immense advantages, but it carries the objection that the architect has little, if any, control over expense. Now, expense is usually the ruling factor in peace-time military works, and the R.E. officer can never divest himself of responsibility for it. Consequently, he must always be so far familiar with the details of works in his charge as to be able to check the designs and calculations of such specialists as may be called in, and to accept some measure of responsibility for the results of their labours.

This requires, first of all, a thorough theoretical training in the general fundamentals of every branch of engineering, and, afterwards, clear and concise guidance from approved manuals or handbooks.

Now a further effect of the peculiarities of reinforced concrete construction is to produce a literature prolific in extent but confined in

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direction to two principal tracks. The one is that of the constructional specialist, who enlarges upon the manifold practical applications of his art until his book assumes the appearance of a maker's catalogue ; the other is that or the designer, who, being mainly interested in theoretical considerations, packs his volume with discussions on the theory of structures.

The student of reinforced concrete *per se* becomes harassed and confused. Detailed practical examples have little value until some personal experience has been accumulated ; while the Theorem of Three Moments, Euler's Strut Formulæ, and Differential Equations for the determination of Bending Moments and Deflection are better studied apart. Between these two tracks, then, there existed a gap, and—be it said without further preamble—the manual under review fits into that gap with striking success, and goes far towards filling a decided want.

The author's intentions are shortly described in the Preface* as being two-fold :—firstly, to provide a manual of instruction for young officers, and, secondly, to offer guidance to others, who may be actually engaged in constructional work. Unlike many good intentions, these are admirably carried out. The book is written clearly and concisely, and follows a perfectly definite and consistent plan.

The theory of the subject is worked out from first principles, and the usual necessary formulæ are arrived at in the same way. The most important formulæ are expressed by graphs, which have been plotted over a full range of common values. By this means cumbrous arithmetical computations are eliminated, and both student and designer are saved much labour. Throughout the book the notation and quantities recommended by the R.I.B.A. Report of 1911 have been followed.

Section I outlines very shortly the basic principles of reinforced concrete design. Section II treats of Bending Moments and Loads. A few standard cases are worked out ; the method adopted, if not entirely satisfactory, being straightforward and easily understood. As already pointed out, this part of the subject belongs to the General Theory of Structures, and there are various ways of approaching the calculations. In order to simplify explanations in subsequent chapters a certain amount of work on the theory of the subject cannot be avoided. It is rightly reduced to a minimum here. The illustrations of typical main beams, facing page 6, are open to criticism. The longest possible clear centre span is usually demanded, which requires two rows of piers, and involves somewhat different mathematical treatment to the cases worked out.

Sections III to VIII are devoted to Singly Reinforced Beams ; Slabs ; Doubly Reinforced Beams ; T-Beams ; Shear Reinforcement ; T-Beams with Fixed Ends.

* The Preface refers to this as the second book on the subject ever published by the S.M.E. It overlooks *Notes on Steel Concrete* by Major J. Winn, published in 1903. Although little more than a *résumé* of a voluminous French work that had lately appeared, it came out at a period when little interest was shown by most British engineers ; and it certainly served to arouse the attention of many R.E. officers, to whom, for some time, it must have been the only introduction to this highly important subject.

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Examples are worked out to illustrate the system of trial and error that is almost always called for in this work. The large number of variables in these calculations often forms a stumbling-block to the inexperienced learner, who lacks confidence in making the necessary assumptions. In the examples given work is much simplified by the use of the graphs, and figures for breadth and depth of beam are usually assumed at the start. For the benefit of the student it should be pointed out that, failing such aids, the determination of the neutral axis is usually the ruling factor ; and, since this may involve awkward arithmetic, it is best assumed straight away.

The section on Shear Reinforcement is excellent, though more emphasis might perhaps be laid on the importance of this subject. Practical considerations so often lead to high ratios of tensile reinforcement being provided, that failure will first occur by shear. This point is seldom made clear in text-books.

Section IX deals with Deflection in Beams.

Section X, which treats of Columns, follows generally on the lines of the R.I.B.A. Report. This part of the Report was, the present writer believes, based on an earlier one (1907) by a French Committee, who proposed a formula for the safe load on spirally reinforced columns, that would have been well worth quoting. It has the great merit for a student of explaining itself at a glance. The formula is :—

$$P = C\,(A + nA_L)\left(1 + m\frac{V_H}{V}\right)$$

where P =safe load on column,
A =Sectional area of column,
A_L =Sectional area of longitudinal reinforcement,
V_H =volume of helical reinforcement,
V =total volume of column,
n =coefficient varying from 8 to 15, and depending chiefly on nature of concrete,
m =coefficient depending on pitch of helix, varying from 8 to 33.

Values of n and m were proposed as the result of extensive trials. The tables in the R.I.B.A. Report are believed to have been elaborated and built up from the French values.

Section XI deals with Foundations ; Section XII with Retaining Walls ; and Section XIII with Members under Direct Stress and Bending Moment.

Section XIV enumerates certain miscellaneous applications of reinforced concrete. In referring to chimneys, the advantages of this form of construction, when ratio of length to diameter is high, are not mentioned. The immense saving in weight and bulk over brickwork has led to a good deal of investigation of recent years into the questions of temperature stresses and effects of hot gases on the concrete.

The final five sections contain brief but useful notes on Falsework, Steel-work, Supervision, Specifications, Commercial Products.

As Appendices are given a list of symbols and a list of formulæ. The

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latter might perhaps have been dispensed with; the time spent in digging a formula out from its proper context is generally time well spent. In its place we would have liked to see a summary of the 1911 R.I.B.A. Report. There follows a number of useful tables, an excellent index, and lastly, the graphs, eleven in number, already referred to.

The book is thoroughly well printed and produced. A short list of *errata* has been issued, mostly minor corrections in the Tables, and no other misprints or errors have been noticed.

As a text-book for the general engineering student, as distinguished from the specialist, this volume can hardly be too highly praised, and deserves a wide circulation. The selling price to the public is not stated,* but the present writer believes that the book only requires to become known to be adopted by many schools of engineering outside the S.M.E.

When the education of R.E. officers at Cambridge was recently under discussion, an opinion was expressed that it was a mistake to adopt any University standard as that required by a military engineer; rather should efforts be made to develop and extend the School of Military Engineering until it came to be recognized by all grades of engineers as the centre of general engineering instruction.

Idealistic in conception as it may be, such a view is probably, if for financial reasons alone, impracticable in realization.

But if the S.M.E. can continue to produce text-books on a level with the Manual of Reinforced Concrete a considerable step in that direction will have been made.

G.H.A.

* The price fixed by H.M. Stationery Office is 10s. 6d.—Ed., *R.E.J.*

NOTICES OF MAGAZINES.

MILITÄR WOCHENBLATT.

No. 51.—In an article on the political position of Poland from the military standpoint, from January to March, 1922, the following situation is recorded:—No material changes have taken place in the Army, the strength of which is estimated at 300,000. Physical training of boys from 7–16 years of age, followed by a military preparation from 17–20 years of age, is carried out on the same lines as in France as a preliminary to military service. The process of arming the light artillery with French guns has been completed. Uniformity and sufficiency of clothing is still lacking. The bulk of the officers are drawn from former Legion and Austrian officers. The French Military Mission is being reduced to 100 officers under General Niessel.

The foreign policy continues to follow the French lead. The object of separating Germany from Russia, from the Black Sea to the Baltic, by means of a Federation of States under Polish domination has almost been attained. Poland has concluded treaties with all her neighbours, Lithuania excepted, with a view to mutual support of French policy at Genoa. She has also made with France an economic agreement which is declared to be disadvantageous to her.

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Poland is not satisfied with the economic inclusion of Danzig in her Customs area, but desires to absorb the Free State of Danzig wholly. Lithuania's aloofness is described as being due to the question of Vilna, a solution for which has not been found. Notwithstanding the fact that a Polish victory was obtained in the elections, England and France have not agreed to attachment to Poland. France favours the autonomy of Vilna in order not to offend the Lithuanians too far.

With the rest of her neighbours Poland has completed a number of important agreements, which, *inter alia*, in case of attack bind the signatories at least to benevolent neutrality. It is suggested, however, that a defensive alliance is certain to exist. The latest changes in the Lithuanian Cabinet are described as favourable to Poland.

The economic situation of Poland is continuing its downward grade. The budget is not balanced. In the opinion of the writer there is no possibility of an improvement.

Captain O. Groos' book, entitled *The War in the North Sea*, receives most favourable mention by Admiral Dick.

Owing to the lack of literature treating with the psychology of the masses, Kurt Hesse's book, *Der Feldherr Psychologos*, is warmly welcomed.

A plea is entered for the introduction of a summer uniform for German officers, who would, it is said, gladly bear the expense in order to obtain the comfort it would give them. The men already possess one.

No. 52.—An interesting review of the political and military situation in S.E. Europe appears. According to the writer, the policy of the Little Entente may be summarized under the following three headings :—

(1) Military encirclement of Germany's former allies, Hungary and Bulgaria (Austria has now been linked up in certain respects with the interests of the Little Entente by the Treaty of Lana).
(2) Economic Union of the Danube States to the exclusion of the sponsorship of the Western Powers.
(3) Equal rights with the Great Powers of Europe in conferences dealing with general European questions.

Considerable progress is recorded, largely owing to the influence of the Czecho-Slovakian Foreign Minister, Benes, to whom the credit for a *rapprochement* with Poland is due. By this means a quadruple alliance between Poland, Rumania, Jugo-Slavia and Czecho-Slovakia has been brought into being. Benes is said to have succeeded in directing the policy of this alliance in support of certain principles at Genoa. These were mainly the inviolability of the treaties which have founded the new Europe ; exclusion of discussion on reparations ; refusal to accept any Danube Confederation ; and an united front against Germany and Russia. Prague is represented as being the centre of the Pan-Slav movement, working to gain influence in European politics with a view to being able eventually to confront Russia on terms of equality should she ever recover her strength ; and concurrently making every endeavour to cut Germany out and establish a firm footing there herself.

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This quadruple alliance, we are told, has a population of 70 millions and possesses an army of about 912,000.

Concerning the individual States the following is reported:—

Czecho-Slovakia.—Progress is being made with the building up of the army. In case of war, 21 divisions are immediately available for service. Special importance is attached to the aerial arm, which is under French direction.

Reference is made to the Treaty with Poland of 6th November, 1921, whereby the military encirclement of Germany in the East has been completed—a success for French policy. A loan of £10,000,000 sterling was successfully raised in England.

Austria.—In virtue of the Treaty of Lana (15th December, 1921), Austria gets a credit of 500 million kronen. This Treaty provides for mutual neutrality in case of attack, and mutual suppression of all activities directed against either State or towards the reconstitution of the former régime. In practice Austria is thereby linked up with the Little Entente. Simultaneously the military ring round Hungary has been strengthened.

The suggestion has been made in the Austrian Press to introduce the Swiss militia system. This proposal is only justified by the financial position and the failure to recruit the army, which in December last was 70 per cent. under strength.

Hungary.—The Entente has succeeded in enforcing the disarmament in Hungary in accordance with the Treaty of Trianon. The question of the monarchy continues to play a not unimportant rôle in spite of the failure of the late King Carl to re-instate himself.

Rumania.—The army estimates for 1921–22 provide for a peace strength of 192,000 men. Rumania and Jugo-Slavia concluded a military convention on 22nd January, 1922, which completed the encirclement of Hungary. Attention is directed to the *entente* with Greece, brought about by the relationships of the Royal Houses; tending on the one hand to counterbalance Italian schemes of expansion at the expense of the Balkans, but on the other to complete the military encirclement of Bulgaria.

Jugo-Slavia.—In Jugo-Slavia no appreciable progress has been made with the reorganization of the army. It remains to be seen if the replacement of General Zicevic by General Vasic will speed matters up. The shortage of junior officers continues. Sanguinary encounters occurred in Croatia and Dalmatia during the mobilization for the suppression of the monarchist rising in Hungary. Germany has concluded a commercial treaty with Jugo-Slavia in which the latter renounces the right conferred on her by the Treaty of Versailles to confiscate German property.

Bulgaria.—Bulgaria is unable to maintain by voluntary enlistment the army allowed her by treaty; last February her army, including *gendarmerie*, numbered 6,000, instead of 33,000. The disarmament of Bulgaria is complete.

Greece.—In Greece it is reported that the French Military Mission ceased work at King Constantine's return, since when relations have become very strained with the Greek officers.

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An interesting article, taken from writings of Oswald Spenglen, appears. He starts with the assumption that the XIXth century was characterized by an absence of great wars and revolutions, when even the most difficult crises were overcome by methods of diplomacy. He then proceeds to argue that the explanation lies in the universal preparedness for war obtaining everywhere, fear of which at the eleventh hour induced postponement of definite decision and the substitution of political moves in lieu. The outstanding features of the XIXth century were giant standing armies and universal conscription.

Historical allusion is made to the growth of armies and fleets since the Napoleonic era. This rivalry is summarized as being "a war without war"—a war for supremacy in armaments, preparedness, numbers, and engineering. The intolerable tension of this condition of things has come to an end with the late war by, it is alleged, the abrogation of universal conscription, a law originating from the French revolution itself. This will result in the replacement of large conscript armies by smaller armies, composed of professional volunteers, who, be it noted, are *soldiers enthused for war.*

Ipso facto this present century must become one steeped in war. The author estimates that two generations will pass before the warlike spirit of these professionals will prevail over the will of the peace-lover. He goes on to prophecy of the vastness of the areas to become involved, together with the ruthlessness with which the wars of the future will be conducted. He supports his argument on the rapidity with which the present generation has acquired the habit of almost ignoring events which, previous to the War, would have shaken society to its foundations. In proof of this he points to Russia and asks who seriously considers the millions who are succumbing in that unhappy land.

He thinks it may safely be assumed that amidst these future catastrophies of blood and horror, the usual cry for reconciliation and peace will be raised in the degree necessary for effectively staying these grand events. However much one may foster the desire for peace it is necessary to face facts as they are. Life, if it is to be great, is hard. The choice is one between victory and defeat—not between war and peace—and the fruits of victory belong to the victor. These truths are apt to become obscured in the turmoil of events, but are confirmed in history, from which the author proceeds to quote, commencing with China, A.D. 535.

The following particulars concerning the production of munitions by Germany during the war are given from official sources :—

The total production of rifles, carbines, pistols, etc., was 10,000,000. Five months after the outbreak of war the daily production was 1,200, which later was increased to 250,000 per month. In July, 1916, the monthly output of machine-guns reached 2,300 ; in the Spring of 1917 it had increased to 7,000, and in the Autumn touched 13,000. The maximum output in hand grenades was attained in the winter of 1916–17, when it totalled 9 millions a month.

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The following monthly outputs (maxima) are recorded.

After 1917, Guns for Light Artillery	3,000
In 1917, Trench Mortars	4,300
Sandbags	20 millions
Steel Helmets	500,000
Gas Masks	500,000

Captain Helling gives a short review of the new regulations for trench mortars.

An article appears deploring the attacks made by the Radical and Democratic Press on the meetings of Associations of ex-officers and men, which are described as, in reality, cloaking anti-republican demonstrations.

A comparison is drawn between the toleration shown to the Red Flag and the hostility evinced to the black, white and red.

No. I.—A political review of events in Russia from the military standpoint, embracing the period February to April, 1922, is penned by von W. He takes the view that no attack by Russia on the Western Front is probable so long as the reorganization of their armies is incomplete. Some particulars concerning the army are given. It is estimated as about equal to that of the Czar's army in 1913–14, *viz.*, 1½ millions. He remarks on the dwindling gold reserve and the effort to improve the situation by the confiscation of Church property—a measure calculated to offend most deeply the religious susceptibilities of the Russian people. That the Soviet Government should dare to place such an act on their statute-books is, for him, proof enough that their power is still maintained, notwithstanding rumours to the contrary. The situation arising out of the Genoa Conference is discussed together with the effects of the Treaty of Rapallo.

The results of the trials of the War Criminals held at Leipzig are declared to have vindicated German innocence—a fact which, in the opinion of the author, is slowly but surely being realized in neutral countries.

Nos. II and III form a combined number, doubtless owing to the strike. General von Altrock writes to refute the complicity of the German officer in the murder of Rathenau.

H. DE C. TOOGOOD, *Captain, R.E.*

28th August, 1922.

REVUE MILITAIRE GÉNÉRALE.

June, 1922.

The Revision of the Regulations.—A continuation of the article by "Lucius," sixth period, continued.—II. *Application to the Great German Offensives of the Spring of* 1918. 1*st.*—The German offensive in Picardy of 21st March was the greatest since the war began. On a front of 70 kilometres between Scarpe and Oise 73 divisions were engaged, 50 of which were brought up by night in seven days. The artillery preparation (12 field and 11 heavy batteries per kilometre, or 1 gun per 10 metres of front) lasted five hours, two of which were against the hostile artillery. The British only were attacked, the 5th Army

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(Gough) by three times its number, and here the Germans broke through. French reserves were hastened up to close the breach, but, if the Germans had had cavalry available, the case might have assumed a different aspect. As it was, the attack was checked by 30th, and when it was renewed on 4th April a new front had been formed round the salient, which was 50 kilometres deep. Ludendorff then suspended the operations in Picardy, and on 9th April launched an offensive in Flanders between the La Bassée canal and Armentières on a front of 15 kilometres (extended later to Ypres) with nine infantry divisions in first line, and later by five fresh ones (artillery preparation, two hours). After an initial success this attack was stopped by the determined resistance of the French at Mount Kemmel (25th April). The salient formed was 12 kilometres deep.

Considering that until the first days of April the Germans enjoyed a superiority of two to one, the reason for their failure requires investigation. The most important one was their lack of adequate reserves. To feed the 73 divisions at first engaged, 10 fresh ones were brought up after the first six days, nine others between 1st and 8th April, and the attack in Flanders required another 38 divisions, a total of 130 divisions or two-thirds of the German force on the Western front. Another reason was want of rapidity in the advance, which allowed of forces being assembled to meet the danger. In fact, once the German infantry was separated from its barrage, its progress was very circumspect and was checked by the slightest resistance. Ludendorff recognized this, and in a series of Notes further defined his doctrines, first postulating that success depends on rapidity and energy in execution, and the initiative displayed by the infantry when in action beyond the first line. He again pointed out the two phases of the battle, the methodical attack on the fortified position minutely prepared and regulated by the higher command, then the attack on troops no longer installed on a continuous line, when long preparation must be abandoned to give no time for the enemy to rally, and success depends on the junior commanders forestalling the enemy. The regimental artillery frequently intervened too late, and Ludendorff foreshadowed the eventual attachment of a group of field artillery, and even some heavy guns, to enable each battalion to dispose of a section of guns and the regimental commander to make his action felt in case of necessity. In another place he indicated the tactics to be followed in reducing machine-gun positions, instead of rushing them with the bayonet. " What is decisive is not numbers, but fire."

After the offensives of 21st March and 9th April the Germans hoped to be able to join up the two salients they had formed. But the common danger had led the Allies to a step in advance towards unity of command and on 26th March the co-ordination of the action of the Allied Armies on the Western front was entrusted to General Foch, and at length, on 14th April he was given the effective command of the allied forces. The Germans had dearly bought their first successes; their losses had been severe, and at least a month would be required before they could attempt a fresh effort, a delay which the Allies could also turn to good account.

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2nd.—General Foch was already preparing a counter-stroke to free the Amiens–Paris railway when he was anticipated by the German attack on the Aisne of 27th May. Faithful to his principles, Ludendorff had chosen the lightly held Chemin des Dames front for his new effort, and, in place of seeking a decision by again attacking the British Army, preferred first to draw the French reserves southwards and exhaust them. The mass of the French Army was now concentrated to the North, where there were many indications of a fresh offensive, and on the 60-kilometre front selected for the attack there were only eight divisions in first and four in second line. However, less confident of breaking through than on 21st March, the enemy limited the objectives to be attained as the general line Rheims–Heights of the Vesle–Soissons. The German concentration of 30 divisions was, with slight exceptions, carried out by night, and, to ensure surprise, the artillery preparation was to last for only two hours and forty minutes—one gun per seven metres in the densest portion of the front. The infantry strength of the attack was 42 divisions or five times that of the defence. On the evening of 27th May the attack reached the Vesle and halted on its objective, when orders were given to push on south and south-west to gain the Marne, which was reached on 30th. Here again a mass of cavalry thrown into the breach would have been of inestimable value to the Germans. On the wings the results were less brilliant, Soissons was captured on 29th, but Rheims held; further efforts failed to enlarge the salient, and by 4th June the 42 divisions had been exhausted by the 50-kilometre advance. The French had engaged all their cavalry divisions and 30 divisions of infantry, also two American and one British divisions. The position was critical and reserves almost all expended. However, Ludendorff was about to open his intended attack on the right bank of the Oise, but required time to bring his artillery from the Aisne, and the proposed date was postponed from 7th to 9th June. His preparations had been detected, surprise was impossible and his losses were heavy. The artillery preparation, as usual by night, lasted 4 hours 20 minutes, and 19 infantry divisions, 13 in first line, attacked on a front of 35 kilometres. The French had 7 divisions in first line, 4 in second, and the attack penetrated 8 kilometres in the centre, but was slower on the wings. On 10th slight progress was made, and on 11th the French delivered an unexpected flank attack with 4 fresh divisions and 163 tanks, which brought the Germans to a standstill by 15th, but exhausted all the French reserves.

The German offensive methods had given them a very large measure of success, but on 9th June Ludendorff had to issue another Note recalling the dominant principles, particularly the boldness and energy to be displayed by the infantry. "Speaking generally, excessive boldness is less harmful than too great circumspection. . . . It is the duty of the higher command to watch the rear and the security of the flanks. . . . The enthusiasm of the infantry, its aptitude for marching, its endurance and spirit of self-sacrifice, notably in the officers, are primary conditions of success." Still, disquieted by the diminution in his effectives, he insisted upon the necessity for husbanding the infantry by greater use of the machine-gun and regimental artillery, and on

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engaging the reserves where the attack was making the best progress. He made it clear that breaking through was of less importance than inflicting on the enemy greater losses than those experienced. On 13th and 16th June he issued further Notes on artillery tactics.

3rd.—It was not until the middle of July that the German Army was again ready to attack; of their 207 divisions 81 were in reserve, but half of these had not been brought up to strength. Meanwhile, on 21st June the German Chancellor, von Kuhlmann, announced that the war could not be decided on the battle-field, on which Ludendorff decided to stake his all. Since the Château Thierry salient (result of the offensive of 27th May) could not be enlarged westwards, he decided to extend it by a grand offensive on both sides of Rheims towards Chalons and Epernay, on a front of 90 kilometres, and if this was successful to open another in Flanders. But in Champagne, East of Rheims, the French had a strongly fortified position, a zone of advanced posts with an intermediate position for the main defence, held by 70 infantry divisions, of which 27 were organized for a vigorous counter-attack. The battle opened on 15th July, after an artillery preparation of 3 hours 20 minutes. On the front of the French IVth Army (42 kilometres) 50 divisions attacked (26 in first line) 13 French divisions, of which only 8 were in first line, but these were supported by a powerful force of artillery. The advanced line was broken, but the intermediate position held, and by noon the attack had failed. On the Marne, the river was crossed on a 22-kilometre front by 13 infantry divisions, of which 8 were in first line. The crossing began during the artillery preparation of 3 hours 40 minutes, in order to bring the infantry to their position of departure south of the river. The French VIth Army of 9 divisions, of which 5½ were in first line, checked the attack by the evening, after it had advanced 5 kilometres, and no German artillery had been able to cross the bridges. However, between Rheims and the Marne the Germans made better progress, advancing 10 kilometres against the French Vth Army, but on 16th and 17th the enemy was checked, while the position of the German divisions, which had crossed the river became critical. On 18th General Foch opened his counter-offensive on the German right flank between the Aisne and Belloy on a 40-kilometre front. The Xth Army, to the north, (18 infantry divisions, 470 batteries, 244 medium and 225 light tanks) attacked without any artillery preparation, and south of them the VIth Army (9 divisions, 230 batteries, 48 medium and 225 light tanks) after 1½ hour's preparation. The Germans were absolutely surprised and retired 8 kilometres on a 20-kilometre front. For 5 days Ludendorff strove to restore the situation but failed, as the French Vth Army was now menacing his other flank. He then issued orders to recross the Marne on night 19th/20th, and to evacuate the salient as far as the Vesle, at the same time renouncing his blow in Flanders. The initiative now passed finally into the hands of the Allies.

A. R. REYNOLDS.

(To be continued.)

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MILITARY ROADS ON THE INDIAN FRONTIER.

Lecture delivered at the S.M.E., Chatham, on 9. 3. 22 *by* Brig.-General G. P. CAMPBELL, C.I.E., C.B.E. (*late Chief Engineer, Waziristan Force*).

MY intention this evening is to draw your attention to one of the great fields of activity still open to the R.E. Officer in peace as well as in war, that is, Road Construction on the N.W. Frontier of India. I intend, also, to bring out certain points which are not found in text-books.

In these trans-Indus regions, Baluchistan and the N.W. Frontier Province, all engineering work, except railways and irrigation, is carried on by the Military Works Services, which is wholly an R.E. organization—hence the R.E. Officers posted to these Provinces have charge of all civil works, as well as those pertaining to military requirements, and so they have a wider scope of employment and interest than falls to the lot of most R.E.'s. It is in these Provinces that all the most important roads have been, and will be, made.

On *Plate* I, I have indicated in *continuous* lines the older of the main strategic roads, most of which were built generations ago and are being gradually improved; and I have shown, in *chain-dotted* lines, the newer roads, some of which are being extended, as the broken lines indicate.

Beginning at the south of this map, the old main frontier roads are the following :—

(A). From Sibi, at the foot of the Baluchistan ranges, through the celebrated Bolan Pass and Quetta, and across the upland plain of the Peshin District to, and over, the well-known Khojak Range and down to Chaman, which faces Kandahar (in Afghanistan).

(B). From Harnai through Loralai away out to Fort Sandeman, which, from the edge of Baluchistan, faces Waziristan in the N.W. Frontier Province.

(C). From Dera Ismail Khan (in the N.W.F.P.) to Tank and on to Murtaza Post, which faces the foot of the great Gomal Pass.

(D). From Dera Ismail Khan to Bannu and Kohat and on to Khushalgarh on the Indus.

(E). From Kohat to Parachinar near the famous Peiwar-Kotal.

(F). From Kohat *via* the Kohat Pass to Peshawar.

(G). From Peshawar through the historic Khyber Pass to Landi Kotal and Landi Khana, which look towards Jellalabad and Kabul. (I refer more fully to this road later on.)

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(H). From Attock to Peshawar :—This is really a continuation of the Grand Trunk Road, which begins at Calcutta, nearly 2,000 miles distant.

(I). From Nowshera through Mardan (the home of the famous Guides) and up the Malakand Pass and on down to Chakdara, facing Swat, Chitral, etc.

For the most part these old roads are wonderfully well graded, and they would disclaim any relationship with the goat-tracks which Devonshire endures, or with some of the roads in Kent. But, of course, they were designed only for medium-paced traffic, and not for motor transport, which has tried them sorely in the recent campaigns. Their defects in these days of fast-moving traffic are :—

(*a*) Narrowness.
(*b*) Sharp, unbanked corners.
(*c*) Shortage in metalling, both in width and depth.
(*d*) Inadequate sizes of bridges and culverts.
(*e*) Defective retaining walls.

These old communications are being gradually improved, and a considerable amount has been done in remedying (*a*) and (*b*), but defects (*c*), (*d*) and (*e*) necessitate heavy expenditure, and their claims are too often met by the heart-breaking reply, "as funds become available."

The modern frontier roads (on all of which, by the way, I have been employed from the rank of Subaltern to that of Brigadier-General) are the following :—

(J). The Takki-Zam Valley Road.—This takes off from Road (C) above, and after rising to the upland of Manzai (where is a new Cantonment) it reaches the right bank of the River Zam at Khirgi Post. From the lofty cliffs of this bank the road descends to the river, which is crossed twice by transferred railway bridges before reaching the next military post, Jandola, seven miles from Khirgi. This "double crossing," which theoretically appears to be an unnecessary luxury, is an example of the fact that, in aligning a frontier road there are other considerations besides those of the engineer. In this case, there were both political and strategical objections to a continuous adherence to the right bank of the river, where the gradients in the broken hills would have necessitated a long detour away from the general direction of the march, and into country that was politically dangerous. As it actually worked out, it was cheaper to construct the two bridges than to make the long detour.

After leaving Jandola, the Zam River is crossed by a third bridge, whose superstructure, like that of those already mentioned, was erected by the N.W. Railway Bridge Engineer (Mr. Everall).

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I must here tell you the history of these bridges, as it shows the great value of intelligent co-ordination whenever this can be established:—When the N.W. Railway, and other Lines in India, increased the size and speed of their locomotives (and rolling stock generally) it became necessary to scrap their old bridges and substitute far heavier sections. The scrapped lattice girders, etc., of these superseded bridges were lying idle in various railway depôts, when a " brain-wave " prompted the M.W.S. to ask for the transfer of these materials, which would be quite adequate for road traffic. They were then collected in the workshops of the Bridge Engineer, N.W. Railway (Mr. Everall), whose services are placed at our disposal and who co-operates with any frontier engineer requiring bridges, and these are devised accordingly. The R.E. officer then designs and constructs the abutments, piers, training-works, etc., and arranges for road transport of the superstructure, which the Bridge Engineer delivers at railhead, and, afterwards, erects on the piers. It is an admirable and economical arrangement, as we get inexpensive bridges, and the railway department concerned gets rid of " surplus material."

I draw your attention to *Plates* II and III, in which are diagrams of two of these bridges. One diagram shows how a *deep* girder can be utilized with shallow ones. The other shows two cantilevers and their anchorages. *Plates* IIA and IIIA are respective photographs of these two bridges.

To continue, as to the Takki-Zam Valley Road.—From the bridge-head at Jandola the road crosses a high stony plain, passes through a small range, and rejoins, and then recrosses, the river, whose right bank it traverses to our further outpost, which is near Makin—the capital of Waziristan. This road is to be extended northwards up over the Razmak Pass to meet the Tochi Road, west of Miran Shah (Dardoni). This latter road I now proceed to describe.

(K). The Tochi Valley Road from Bannu to Datta Khel (which looks towards Ghazni in Afghanistan) covers a distance of eighty miles. I personally made the first survey and alignment of this road, which I began in 1896–97. Since then the work has progressed " as funds became available " (as I have said before), and latterly it has been immensely augmented by Major A. H. Bell, R.E., who wrote an excellent and interesting description of it in the *R.E. Journal* of October, 1921.

During the recent Waziristan Expedition, in 1919–20, the Tochi River was spanned by two lattice girder bridges transferred and erected by the N.W. Railway. These bridges (shown in *Plates* V and VI) were inserted so as to enable us to divert the road away from a dangerous hill which produced landslides like avalanches, and frequently blocked the road for a week at a time. The result now is that the first forty miles of the Tochi Road, *i.e.*, as far as Dardoni

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(the cantonment of Miran Shah) are always open, and the military posts can always be rapidly reinforced at any season of the year.

Westward of Dardoni, the Tochi Road to Datta Khel was in course of completion, under Major Bell, when orders were received for the evacuation of the Upper Tochi, owing to the Afghan War of 1919—but the construction will now be resumed and a "ring fence" will then encircle Waziristan.

(L). The Khyber Pass Road.—I have already referred to this—*vide* (G) above—under the heading of "Old Frontier Roads," but it has been so much improved in recent years that it has now come under the designation of a "Modern Frontier Road." For many centuries this celebrated Pass has been the main outlet from Central Asia to India, and it has probably seen more fighting than any locality in the world. From generation to generation that unconquerable force called "Trade" has evoked, and invoked, the transit of great camel-caravans, whose owners and guards, called "Powindahs," have fought their way, step by step, with the produce of Central Asia or the products of Hindustan (including "Manchester goods").

When I took over the Khyber, about eleven years ago, there existed what is called a "cart road," which was duplicated for a few miles, and which possessed all the defects of frontier roads. The advent of fast-moving traffic, and the needs of modern warfare, rendered imperative the complete modernization of this important Line of Communication, and, at last, "funds were forthcoming." Hence, I was able to transform, and duplicate, the road from Jamrud (which is at the foot of the Pass on the Indian side) to Landi Khana, which is twenty-five miles distant, and on the Afghan Border.

The circle formed by what we called the "North Road" and the "South Road" would now provide an excellent arena for "motor trials."

These three roads, namely, the Tochi Valley, the Takki-Zam and the Khyber Pass, embody the latest specifications of the Government of India, as expressed by the Director General of Military Works, for the construction of Indian Frontier Roads. In them, rigid economy has been practised, and (to quote from General Sir George Scott-Moncrieff's article in the January number of the *R.E. Journal*) the "*Best*" has not been allowed to become the enemy of the "*Good*."

I shall refer to these roads again, when describing the laying-out and construction of a frontier road.

The *Life History* (to use an entomological expression) of a frontier road is as follows:—

(*a*) Orders arrive from G.H.Q. for the construction of a motor transport road between, say, point A and point B, which hitherto have been connected only by a camel-track mostly in the bed of a

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wide river. A rough approximate estimate is called for, simultaneously.

(*b*) The Engineer Officer in charge proceeds to make a road reconnaissance. This is a matter of his own *personal* labour, and must be done on foot, not once, and not in one direction, but dozens of times and from each end of the route. This necessitates many excursions up side ravines (or *nullahs*, as they are called) and on to adjacent hills and spurs. As reliable maps of the country may not exist, a rapid survey must be made, so as to indicate clearly to co-ordinating officers the general direction proposed, and the adjacent features of the land. During this preliminary prospecting, the Engineer Officer in charge will choose his engineering obligatory points, such as the lowest point for crossing a range, or bridging a river, or the point of diversion, so as to avoid a rotten hillside, or to steer clear of a precipice.

(*c*) The next step will be the consultation with officers of other branches, or Services, who, you will find, may have a good deal of influence on the route to be adopted. These officers are :—

(i) The General Staff of the force in occupation.
(ii) The local Political Officer.
(iii) The local Irrigation and Forest Officers.
(iv) The Officers commanding posts, etc., *en route*.

With reference to (i) and (ii) I have given already (in the case of the Takki-Zam Valley Road) an example of the strategical and political considerations affecting the choice of a route which, though favourable from an engineering point of view, was unfavourable from the points of view of the G.S. and the Political Department. Furthermore, the Political Officer will point out cemeteries or irrigated lands or Mosque property, etc., which it is necessary to avoid.

With regard to (iii) it might happen that the best engineering-alignment would seriously interfere with some projected irrigation scheme, such as a catchment-area, or site of a reservoir, etc., or possibly the road-making might ruin a forest-conservation, or destroy an area most suitable for forest-nurseries, etc.

As to (iv) an Officer who spends all his days and nights in a certain outpost has many small needs which the new road may affect adversely, or greatly improve. These small points do not come under the wide vision of the G.S., but they are important to the little garrison. I specify such items as aligning the road so as not to spoil the access to water-supply, or the field of fire, or the vegetable garden, or the conservancy area, or the ventilation, which a high embankment might cut off.

There are other important considerations which would seem to require a sort of prophetic vision, on account of the vagaries of strategical and political policies. Among the frontier hills there are

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very few level, or even moderately smooth, pieces of ground which could be utilized for " landing grounds " for aeroplanes, or camping grounds for troops, or station yards for railways, or dumping grounds for military stores. Therefore, unless wide areas can be provided on both sides of the road, it is wiser to skirt these attractive level patches than to bisect them with the road alignment. I urge this consideration particularly because, on a certain occasion, railhead was suddenly extended to the north, instead of to the west, and, simultaneously, an aerodrome was ordered near the site of the new railhead, and consequently I had to " cross lift " my bran new completed road, for some hundreds of yards, and at huge expense. In this regard, it may be necessary to readjust the levels of the formation line of the road, so as to admit of easy access to it from the future aerodrome, dump, etc. If all these things are thought out carefully in the initial stages, the Engineer Officer will save himself much criticism and the " hot-weather irritation " which the recasting of a *completed* work always causes.

(*d*) The next phase is a more detailed survey of the alignment, with an Abney's level or Clinometer, and the ever-insistent tape-measure. During this stage the sizes and numbers of culverts, bridges, retaining walls, cuttings, embankments, and motor-sidings and so forth, will be noted, as also the localities for water and stone, and their " lead."

(*e*) With these details there is prepared the " Rough Approximate Estimate," for which the Engineer Officer in charge will be " reminded " by G.H.Q. very early in the proceedings. Generally, orders to commence actual work accompany the sanction to this " Rough Approximate Estimate."

(*f*) While awaiting the sanction of this Approximate Estimate, the Engineer Officer sets about preparing contracts, gets into touch with the headmen of tribes (for earthwork contracts), makes arrangements for the transfer or purchase of steam-rollers, coal, tools and plant, and tents, etc., for engaging the necessary staff of officers, overseers, draftsmen and estimators (and possibly Labour Corps). All these things should be carefully anticipated so that when work commences the Engineer-in-Charge is not worried by unnecessary " office work " and " eleventh-hour " indents and requisitions, and so on, and so forth. All this " appreciation of the situation " is called, in Hindustani, " *Bundobust*," which is an admirable and comprehensive term. It is by *bundobust* a man is judged and succeeds, it is by *bundobust* a man is saved worry by day and insomnia by night.

(*g*) On receipt of the sanction of the " Rough Approximate Estimate " and of authority to begin construction, the *bundobusts*, referred to above, are made operative. Frequently the sanction is accompanied by a long list of criticisms and suggestions, which must

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be attended to and adopted unless authority is obtained for one or other alternative, which only local knowledge can maintain.

(*h*) Thereafter the " man on the spot " leads a strenuous and very happy life. Before him there lies a job, an intelligent job, an interesting job, and he feels that, though he may not be " making History " he is undoubtedly " making Geography." Given health and strength, a man needs no finer task than this, and he is reminded of Rudyard Kipling's address to the Students of the North London Hospital: " *Well, Gentlemen, I wish you what all MEN desire—Enough work to do, and enough strength to do the work.*" Of course, there arise many obstacles, but they are merely interesting problems to solve. There are also long hours, and journeys, and belated meals and bad weather, and, at times, it seems as if Nature had signed an offensive alliance with Human Nature, by causing a sudden and urgent need of labour just when " Labour " either refuses to stay on the works, or develops " mumps " (a not infrequent disease in Labour Corps). This embankment " sits down," that cutting " falls in," such-and-such a culvert is badly " scoured out," there has been a landslip on such-and-such a slope, and the Zakka-Khel labourers, or the Mahsuds, find the weather too hot and they want to go back to their own hills. But all these difficulties are not comparable with the real trouble occasioned by lack of *bundobust* in the preface of the job. For instance :—It is very trying, indeed, to see road metal ready for consolidation but no rollers at site, labour arriving, but not enough overseers or tools present, a rock-cutting held up for want of fuzes or detonators, time wasted by workmen going to the springs, or the river, as there are no water-carts. These are the real exasperating troubles which make young men grey, and old men haggard. I stress this subject of initial *bundobust* because I have seen so many instances of collecting " arms " while the " fight " is on.

During the progress of the work the Engineer finds who are the principal enemies and the chief friends of the road.

The road's *Enemies* are as follows :—

(i) Water.
(ii) Bad quality of stone.
(iii) Adverse strata of hillsides.
(iv) Rotten soil.

Of these enemies Water is the most persistent in frontier road-making. For long months it will never appear, and then it comes down like a " wolf on the fold," the whole annual rainfall of England delivered pell-mell in a few days. Down come the rivers in wide, foaming spate, and down the nullahs tear Niagara-like rapids, ripping and delving, and inundating with shingle as well as water, and overflowing from the choked drains and devastating the carefully graded road surface and embankments, and converting the culverts

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into grotesque *islands*. Water is a plague, and worse than that, as it often makes the most careful engineer imagine that he has mistaken his vocation. To meet most of its attacks the engineer must take the following steps in the very inception of the road.

(*a*) Make an accurate survey of the drainage area for every culvert and bridge. This is most important.

(*b*) Ascertain from local and careful enquiries the highest flood level—and then don't trust the local statements—add 20 per cent.

(*c*) Add 20 per cent. to the waterways and foundations, etc., given by the best calculations and data of all your text-books.

As to the second "enemy"—bad stone—This may be friable sandstone or laminated shale. The former will crush or wear away to dust, the latter will never consolidate. Fortunately, most river-beds and ravines on the frontier contain masses of sound limestone boulders, which break up into the "prisms" needed for the bonding together of "road metal." Otherwise one must carry stone from a distant and "almost inaccessible" quarry, which is a very slow and expensive business. On the D.I. Khan–Tank road, during the Waziristan Expedition, the cost of metalling ran to Rs.50 per 100 cub. ft., whereas in other localities the rate was Rs.10 or Rs.12.

Enemies (iii) *and* (iv) (as instanced in my remarks about the rotten hillside on the Tochi Road) necessitate great expenditure and invariably let one down at some time or other. It is cheaper and better to incur the extra initial cost of a long detour than to tackle a "natural fault."

The "*Friends*" of the road are as follows:—

(v) Water.
(vi) Knowledge of the vernacular.
(vii) Good temper.
(viii) An "eye."

Of these "friends," Water is quite indispensable. It is required for consumption, consolidation, the steam-rollers, the mortar, the animals, the building, and for sanitation. It is well worth while spending your savings on the bringing of it close to the site of the works by a small irrigation channel, or a pump and piping.

Friend (vi) saves misunderstandings, delay and expense, and so it must be acquired at a very early stage. I recall an occasion of an officer's whole day being spoilt by his ignorance of the vernacular and his trusting a native who spoke a little broken English. The officer ordered the servant to follow him out to a certain place with his *telescope*. The servant arrived, hours afterwards, with his master's *R.E. blazer* saying, "I bringing Master's *tennis coat*"! A knowledge of the vernacular is a most impressive attribute, and

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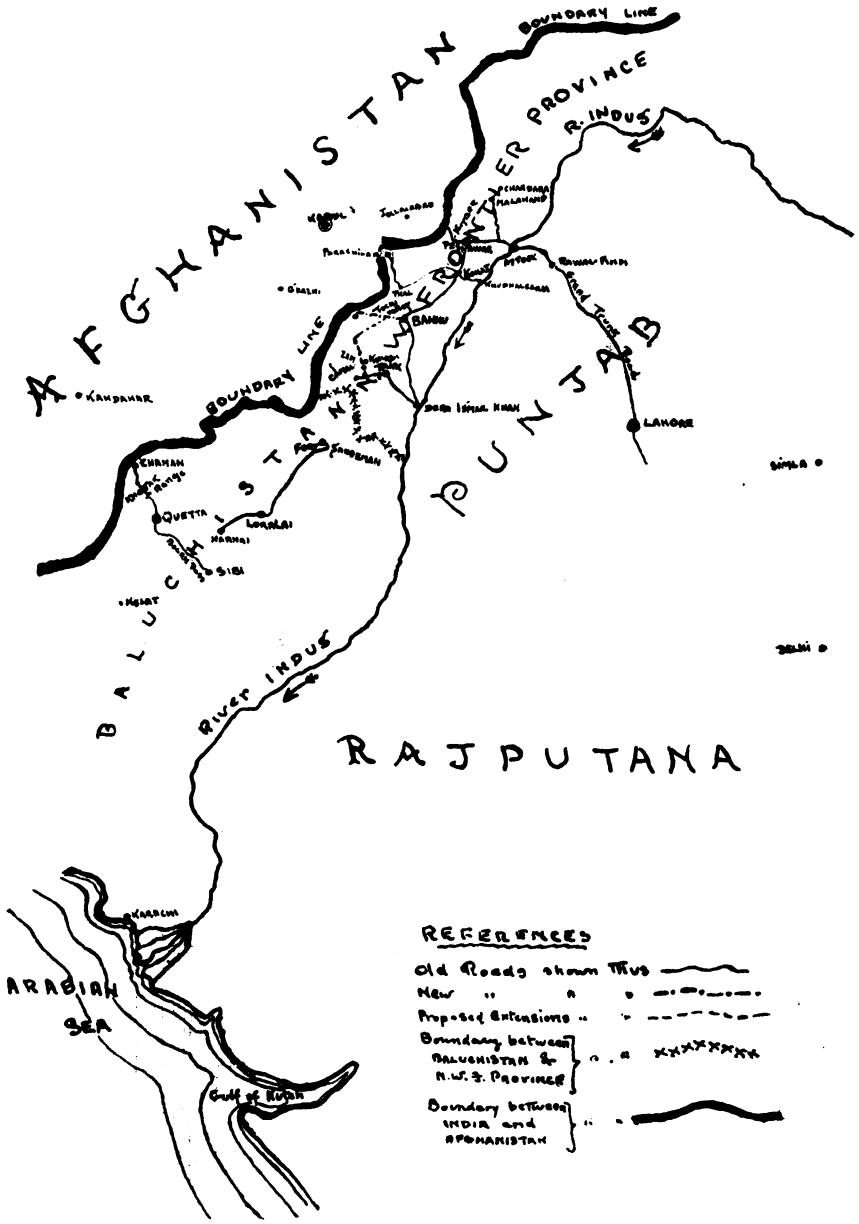

Sketch Map showing North-West Frontier of India.

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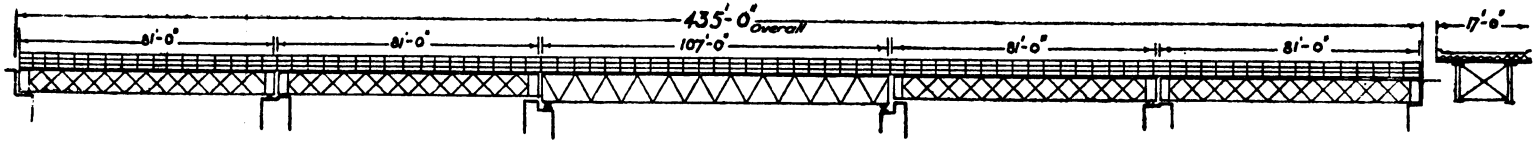
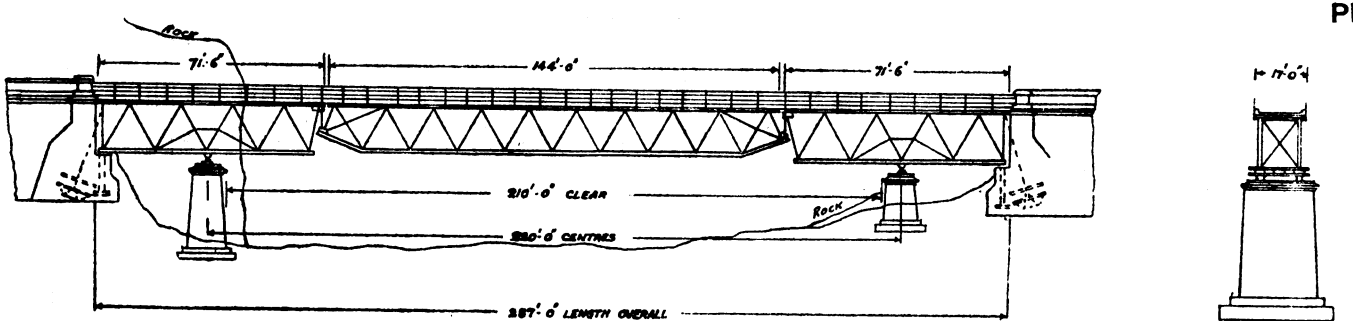
Plate II.



Southern Waziristan, Zam Valley. Lower Zam Bridge on Kaur Jandola Makin Road.

Plate III.



Northern Waziristan, Tochi Valley. Lower Shinki Bridge Across the Tochi River on the Tochi Datta Khel Road (Trans Frontier).

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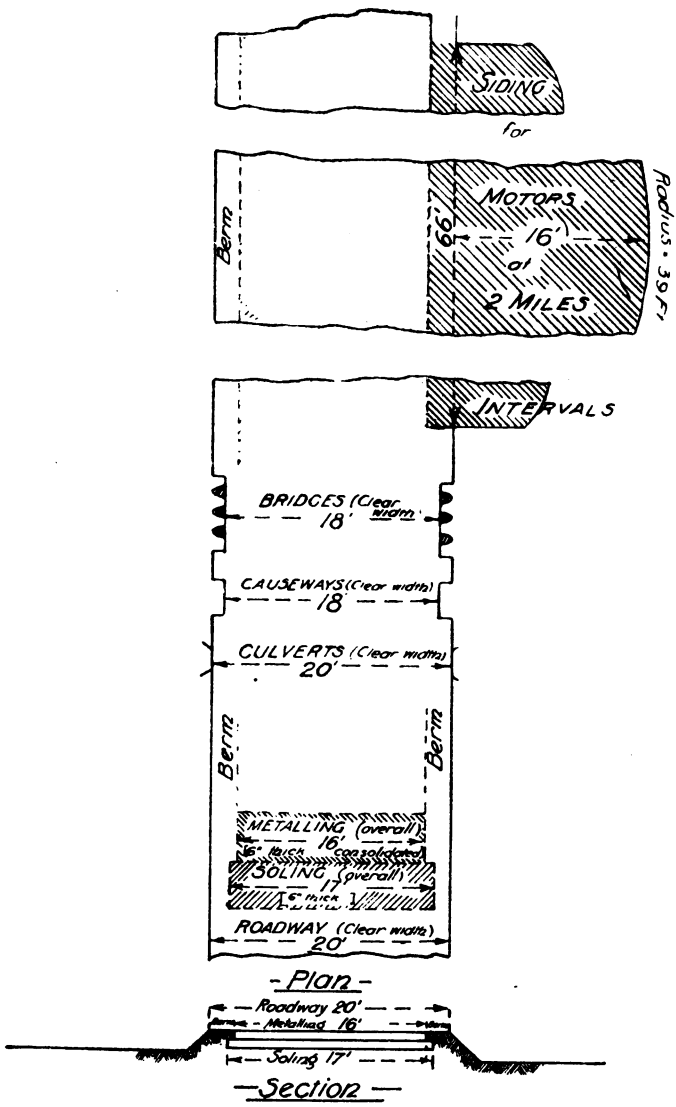

Plan and Cross Section of Normal Piece of Hill Road.

Scale :—4' to 1".

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Plan and Cross Section of [illegible]

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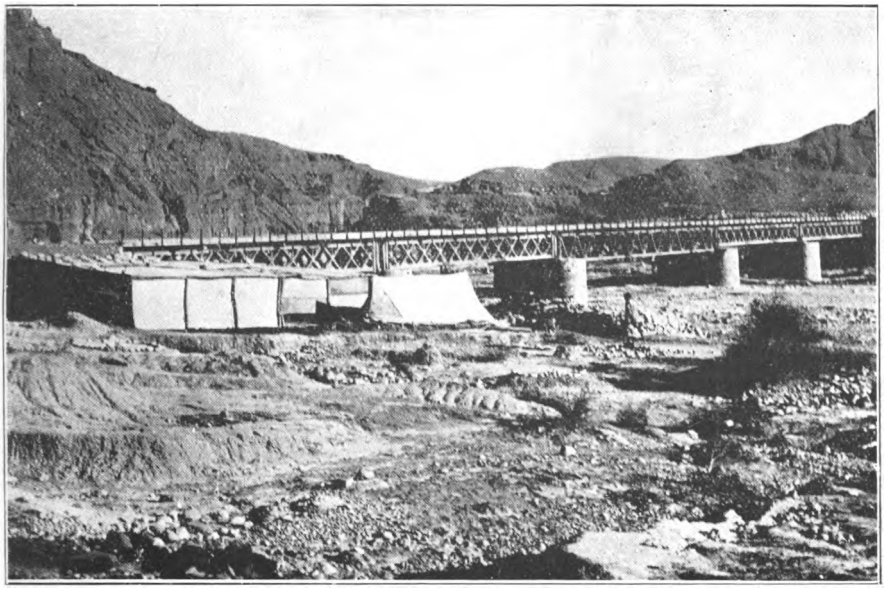
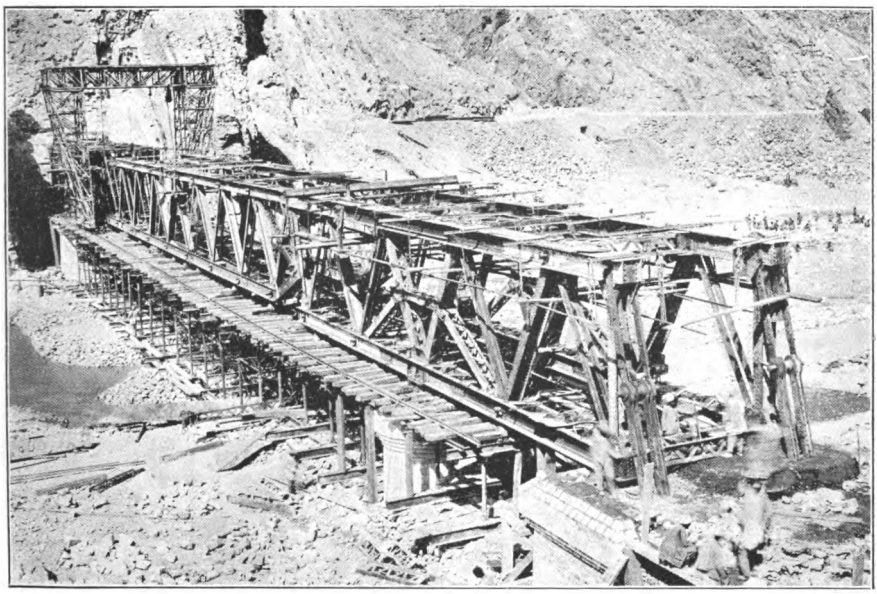
Plate IIA.



Lower Zam-Valley Bridge, S. Waziristan. [*Vide also* Plate II.]

Plate IIIA.



Lower Shinki Bridge, Tochi Valley, N. Waziristan. [*Vide also* Plate III.]

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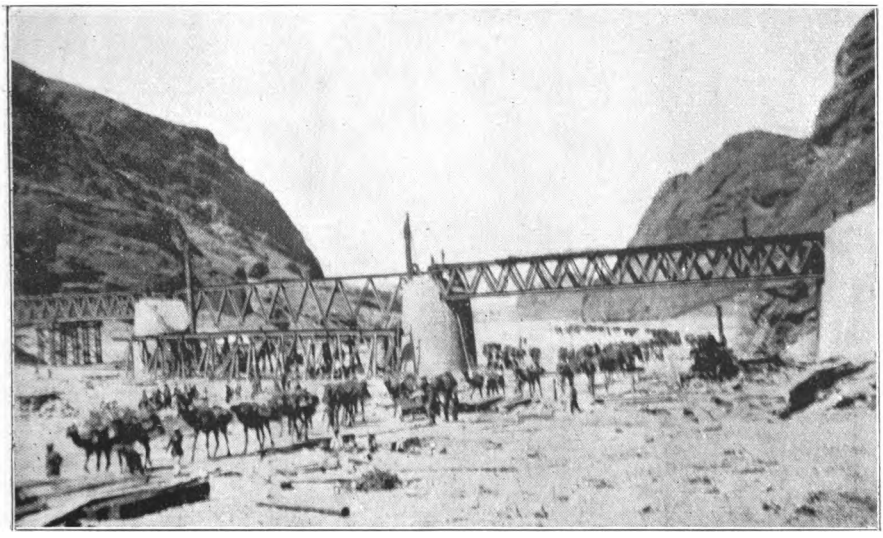
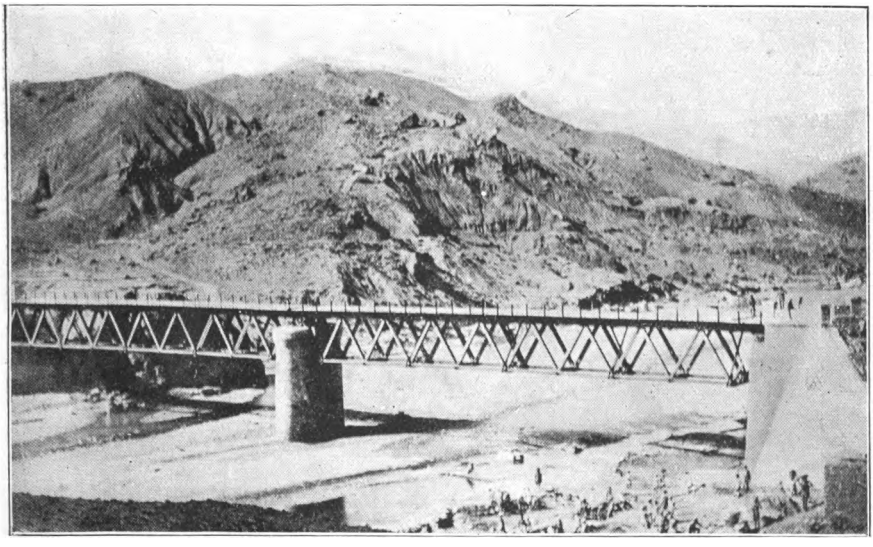
Plate V.



Upper Zam-Valley Bridge, S. Waziristan.

Plate VI.



Upper Shinki Bridge, Tochi Valley, N. Waziristan.

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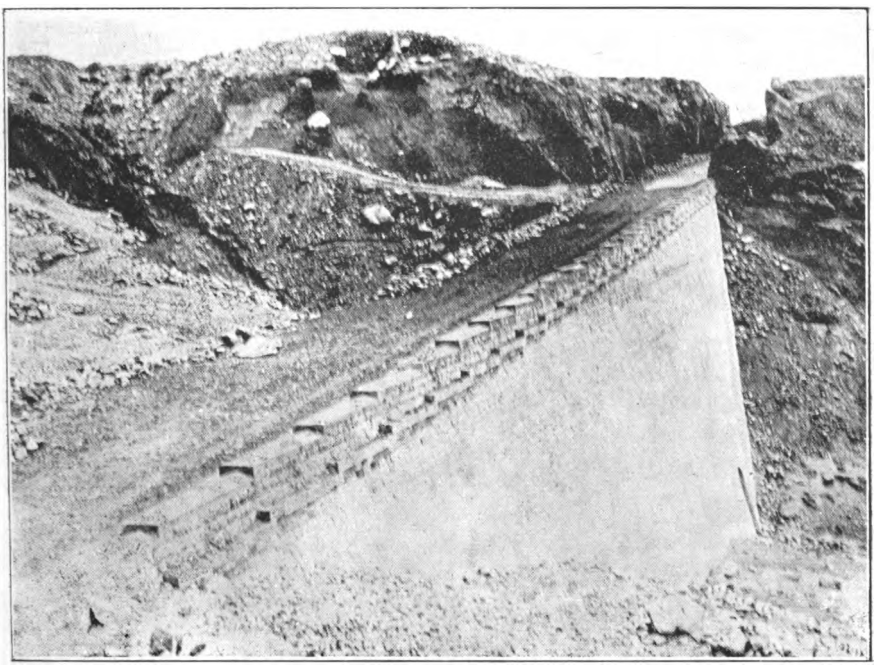
Plate VII.



Dry Stone Wall 45ft. High, Tochi Valley, N. Waziristan.

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it saves much injustice on the part of the unscrupulous native overseer.

Friend (vii).—Before I first went to the frontier I received the following advice from Captain (now General) Ferrier :—" Always keep a thick stick handy and always keep your temper." A thick stick is always a weapon drawn, and ready to keep at a distance a fanatic's knife. A bad temper evokes such a knife, and, at the least, causes discontent, inferior work and slow progress, as these proud frontier workmen resent being " cussed " ! Good temper and cheerfulness are worth six " road-rollers."

Friend (viii).—The possession of an " eye " is a priceless one. By " eye " I do not mean only the power of observation, but the power of assortment. It is this latter power which produces what General Duperier, of the Corps, used to call " taste " in road aligning. Curiously enough some men never possess or acquire it, and so their roads somehow do not seem to fit the country. There exists a slanderous story about a certain engineer officer in the Terah Campaign, who is reported to have diverted his road round a rose-bush ! *This* attribute of the " eye " is mostly exercised in the laying out of the alignment.

The *other* attribute, *observation*, makes one think of Tosti's song, " The night has a thousand eyes," for it sees everything, everywhere, every moment. Bad work, bad system, bad material, bad personnel, are pounced upon at once and eradicated forthwith. The wide area of the " works " demands keen observation.

* * * * * *

As the time is getting on, I must now turn to the question of Specifications, and points of Construction.

The special orders for the construction of military frontier roads in India are laid down in a pamphlet entitled " General Specifications for Military Frontier Roads," which was issued by the D.G., Military Works, in 1919–20. But the general orders for military road-making are contained in that *vade mecum* of M.W.S. officers, namely, *The Military Works Handbook.*

On *Plate* IV I have indicated the main details of a normal piece of hill-road according to the particular specifications issued by the D.G.M.W. You will observe that the items are as follows :—

(i) Clear width of *road*, 20 ft.
(ii) Width of soling, 17 ft. (and 6 in. thick).
(iii) Width of metalling, 16 ft. (and 6 in. thick when consolidated).
(iv) Clear width of culverts, 20 ft.
(v) Clear width of causeways, 18 ft.
(vi) Clear width of bridges, 18 ft.
(vii) Motor sidings, 66 ft. long by 16 ft. maximum width. The outer edge an arc of 39 ft. radius, and whole area metalled, up to road-metalling line.

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Additional orders, and variations, which could not be included in this plate are as follows :—

(viii) Ruling-gradient, 1 in 20.
(ix) Maximum ditto, 1 in 13 for not more than a length of 100 yds.
(x) Corners—Minimum, Centre-Line-Radius, 35-ft. Road to be level throughout and for 20 ft. on each side of curve. Width of road to be 24 ft. and metalling correspondingly widened on outer edge.
(xi) Corners—Banking, 1 in 10 (for 35-ft. radius).
(xii) Camber on the flat, 1 in 40 and continued across the berms.
(xiii) Camber on gradients, *nil.*
(xiv) Extra soling, (*a*) Embankments 3 ft. high and over } To cover whole width of road.
(*b*) At blind salients in hills }
(*c*) On exceptionally soft ground } Ditto, and 9 in. to 12 in. thick.
(xv) Ramps of causeways, 1 in 14 to 1½ ft. above H.F.L.
(xvi) Handrails or parapets, 2½ ft. high.
(xvii) Parapet guard walling, 2½ ft. high and in lengths of 6 ft., with 1 ft. intervals.

I may here refer, for information, to one or two subsidiary points, or " odd jobs," which the maker of the main road will have to carry out :—

(i) Ruling gradient for camel road, 1 in 10.
(ii) Maximum gradient for camel road, 1 in 8 for not more than a length of 400 ft., and provided that there is a similar and adjacent length of 1 in 12, and rise in 1 mile does not exceed 500 ft.
(iii) Ruling gradient for mule road, 1 in 7.
(iv) Maximum gradient for mule road, 1 in 5, for not more than 200 ft., and if " easies," as above, are provided and rise in mile does not exceed 750 ft.

While on the subject of gradients, I may remark that there used to be a rule that, to avoid an ascent, it is advantageous to make a detour equal in length to twenty times the height of the ascent. In other words, it is better to " go round " half a mile than " cut through " by an ascent of 100 ft. For camel and mule roads it is useful to *remember* (if you are running a rapid section, say, with an Abney's level) that $\frac{1}{8}$ equals 7°, and $\frac{1}{7}$ equals 8°. Also 1 in 20 equals 3° nearly, and 1 in 13 equals 4½° nearly.

For wheeled traffic (which includes Field Artillery and A.T. carts) the rise per mile should not exceed 240 ft.

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Lastly, at a slope of 1 in 20, a horse's tractive power decreases by 50 per cent.

So much for the general lay-out of the road. The following are the chief points as to the materials employed, and how they are used :—

(i) *Preparing Ground.*—Before laying down the soling, the ground surface must be barrelled or levelled (according to whether the road is across flat land, or on a gradient), and watered and rammed.

(ii) *Soling* consists of large boulders hand-packed (on the graded and barrelled ground surface) 6 in. thick, with interstices filled with splinters of stone, so that the whole forms a rigid foundation for the metalling. Soling should not be laid on embankments till they are thoroughly consolidated. Soling, when laid, must be passed by an officer, or at least a reliable upper subordinate, as nothing, afterwards, can make good the defects of bad soling, except uprooting and relaying the road. Soling is not required on hard rocky ground.

(iii) *Metalling.*—On, and along, each edge of the soling, when laid, there is made a small earth border or " bund," puddled on inner face, and of same height as the metalling, which these " bunds " keep accurately in position during the rolling. As I mentioned above, under the heading of " Enemies of the Road," metalling must consist of tough, hard limestone " prisms." To obtain these shapes from the breaking of boulders, no boulder of less than 8 lbs. in weight should be broken into road metal. These prisms should pass in any direction through a ring 2 in. in diameter. Before being used, the broken stone is passed over a ½-in. screen, and the screenings are carefully collected, and stacked, for " top dressing."

(iv) *Laying Metal.*—A layer of 4½ in. is first spread on the soling, and this is consolidated to 3 in. before the next 4½-in. layer is put down.

(v) *Consolidation.*—Rolling commences at the edges and works towards the middle gradually. The metal is rolled dry twice, and thereafter it is freely flooded during the rolling. The number of traverses of the roller varies with the quality of the stone used, amount of water, etc., but the usual test of " completion " is that a light cart makes no impression on the rolled metal. Generally, a 10-ton roller consolidates about 1250 sq. yds. daily.

(vi) *Top Dressing.*—After complete consolidation of the two layers (of 4½ in. each) to 6 in. packed, the " screenings "

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alluded to above, together with sand or gravel, are spread evenly to a depth of not more than ½ in. and watered and rolled. This fills up the interstices of the metal and makes a water-tight surface. No earth should be allowed for this, or any, process of consolidation. The native, if left to himself, would put a layer of earth on top of the soling, or even mix it with the metalling; this forms a sort of "mud concrete," which is easy to consolidate, but produces disaster as the earth dries and "works out" and all the metalling wears loose at once.

In the adaptation of existing metalled roads, *i.e.*, "Old Frontier Roads," etc., the Director General's Specification orders the following:—

(i) If existing metal is less than 4 in. thick and there is no soling, reconstruct entirely like a "New Road."
(ii) If existing metal of an unsoled road is 4 in. thick, or more, lay on top of it the usual two layers of new metal 4½ in. thick (consolidated to 3 in.).
(iii) If existing road *has* soling under the metalling, add enough new metal to the old to give a total consolidated thickness, including the soling, of 12 in.

As the 10-ton steam-roller is universally employed on Indian roadwork, I mention its performances, etc., for a 10-hour day:—

(*a*) Consolidates about 1,250 sq. yds. of metalling.
(*b*) Consumes 5 cwt. of coal or 12 cwt. of wood.
(*c*) Evaporates 300 gallons of water.
(*d*) Load on front wheel, 4 tons.
(*e*) Load on each hind wheel, 3 tons.
(*f*) Raises steam in 1¼ hours.

* * * * * *

I have now disucssed the prominent points of frontier road-making, *viz.*:—

(*a*) Selection of the alignment.
(*b*) General construction.
(*c*) The metalling.

Time does not admit of detailing information as to:—

Culverts.
Causeways.
Drainage.
Retaining walls.
Training Works, etc., etc.

All of which follow principles common also to other localities in

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India, besides the Frontier. But I may specify the following peculiarities of Indian hill-roads, as differing from English road-work.

(*a*) Extensive use of *dry*-stone-walling. For instance, in the Tochi Valley, Major Bell built two dry stone retaining walls 45 ft. high. (See *Plate* VII). (Again a case of the "*Best*" not being allowed to be an "enemy of the *Good.*")

(*b*) *Dry*-stone culverts up to 4-ft. span.

(*c*) *Causeways*, or Irish bridges, or "Gaps," *vice* culverts or bridges.—These are the "abomination of desolation," especially to motorists.

(*d*) "*Training Bunds*," which are earthwork spurs, boulder-faced, and designed to direct an erring stream in the way it should flow, *i.e.*, *under* the bridge (and not round it).

So much for a task, the successful completion of which, in spite of every difficulty and of many trials, must recall to the builder's mind these lines (which, curiously enough, appeared in *Punch*) :—

"*Pluck* wins, it always wins, tho' days be slow,
And nights be long, 'twixt days that come and go,
Still, *Pluck* will win, its average is sure.
He wins the prize, who doth the most endure,
Who faces issues, he who *Never* shirks,
Who waits, and watches, and who *Always* works."

REMARKS *re* LANTERN SLIDES.

(Some of which are reproduced in this issue.)

1. I am indebted to the *D.G. Military Works, India*, for the larger view in the Tochi.
   To *Major A. H. Bell*, O.B.E., D.S.O., *R.E.*, for the smaller of the Tochi views.
   To *Major Wauhope, I.A.* (a Memoir of whose father appeared in the March issue of the *R.E. Journal*) for the views in the Zam.
2. Generally, these views show the nature of the wild, barren country of "The Frontier."

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THE WORK OF THE SURVEY OF INDIA.

By COLONEL SIR CHARLES CLOSE, K.B.E., C.B., C.M.G., F.R.S.

THE last annual report of the Survey of India deals with the year, 1st October, 1920 to 30th September, 1921, and the outstanding features of the report may be briefly summarized as follows :—The total out-turn of topographical survey was almost exactly 40,000 square miles, a " fairly full " programme of work having been carried out. The scales were mostly one inch and half-inch to the mile. No field operations were carried out by the astronomical, trigonometrical, pendulum or base-line parties, but tidal and levelling operations were continued, as were the observations at certain stations of the magnetic survey.

From a military point of view, the progress of the new topographical survey is a matter of moment, and it will be interesting to note what the report has to say on the subject. The total area of the Indian Empire, which is to come under the scheme for modern topographical mapping, is 1,821,600 square miles. The original programme dates from 1905, and is based upon the report of a Committee which was appointed to consider the future work of the Survey. This Committee recommended the one-inch as the standard scale, a very doubtful recommendation which was adversely commented upon at the time. Subsequently, in 1913, the Secretary of State " sanctioned a scheme for the reduction of the scale of survey of certain sparsely populated areas."

The total area which remained to be surveyed in September, 1921, was 1,240,865 square miles, or two-thirds of the whole ; and if the original ideas had been adhered to the programme would not have been completed until about 1950 and would have taken some 45 years. These figures are, of course, only approximate, but they may serve to fix the ideas. It should be noted that, as was natural, during the war years the out-turn fell—from average of about 40,000 square miles to 25,000.

Of the 1,240,865 square miles remaining for survey, it is stated that 569,800 are likely to be surveyed on the half-inch or smaller scales, leaving 671,065 for the one-inch scale.

There is a good working rule that, other things being equal, the cost of a map varies roughly as the scale. Thus, a one-inch map will cost twice as much as a half-inch map and so on. The same applies to the time required for survey. In 1920–21, the Survey executed, in round numbers, 2,000 square miles of two-inch work, 27,000 of one-inch, and 10,000 of half-inch. This is equivalent to about

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36,000 square miles of one-inch survey, and we may, perhaps, take this as a likely figure for future years.

Of the area which will probably be mapped on the half-inch or smaller scale, we may, for want of exact information, allow 285,000 for the quarter-inch and a similar area for the half-inch. Accepting the above premises, the conclusion follows that it will take 25 years from 1921, to complete the programme commenced in 1905; the early sheets will then be more than 40 years old.

In the above calculation, no allowance has been made for revision, and yet it is certain that some areas will need revision during the 40 years indicated. If any revision is undertaken, either the department must be materially strengthened, a contingency which does not appear very probable, or the completion of the modern surveys will be still further delayed. Is it unreasonable to suggest that the remedy is to reduce the area allotted for one-inch survey very considerably and to survey the bulk of the Indian Empire on the half-inch scale?

The field work of this great department has always been of an admirable quality, and in recent years the maps have been well printed in colours. This could not be said twenty or thirty years ago. For in those days the standard sheets did not do justice to the skill and care of the field topographers. The writer can well remember the disappointment with which he examined the printed maps resulting from a field season in Burma in 1890–91. But since Sir Coote Hedley's visit to India—which was one of the good results of the report of the Committee above-mentioned—the maps have steadily improved in appearance and legibility, and are now excellent examples of colour printing.

In this the Survey of India profited from the experience of the Ordnance Survey; but the debt is not entirely one-sided, for, in a day in which the scientific side of surveying was dead in the United Kingdom, the scientific spirit was kept alive in India, and reacted favourably on the Home Survey later on. Moreover, the topographical field methods now in use, not only on the Ordnance Survey for training the Survey Companies, but in the Survey School at Chatham, and in the Crown Colonies and Protectorates, are directly derived from India. The two Surveys have, in fact, always much to learn from each other.

Before closing this brief outline of the present activities of the Survey of India, mention should be made of the excellent progress that India has made with the International Map of the World. No fewer than 15 sheets of this series are in hand or published, and, of these, nine have already been issued. This is a larger block of sheets than is to the credit of any other country. Geographers interested in the *Carte du Monde* are much encouraged by the splendid progress made by the Survey of India.

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AN OUTLINE OF THE EGYPTIAN AND PALESTINE CAMPAIGNS 1914—1918.

By MAJOR-GENERAL SIR M. G. E. BOWMAN-MANIFOLD, K.B.E., C.B., C.M.G., D.S.O., *p.s.c.*

(Continued).

CHAPTER X.

THE ARAB ARMY.—The Desert Arab temperamentally unfitted for normal warfare —Creation of a regular army for the Hedjaz—Feisal's move to Wejh—Captain T. E. Lawrence's theory of a warfare suited to the Arab—Capture of Akaba from inland—Investment of Maan—Tasks of the Arab Army during the Beersheba–Jerusalem operations—Growth of the Arab Army: Feisal's flying column.

THE ARAB ARMY.

AFTER the Sherif of Mecca's revolt in June, 1916, the Turks sent reinforcements by rail to Medina, and seriously intended to crush the Arabs, and retake Mecca.

Although the desert Arabs of the Hedjaz were fired with enthusiasm for the cause of freedom, and wished to win it for their country, and their less fortunate kin, they were temperamentally unfitted to oppose trained troops in normal warfare. They were volatile, and handicapped by tribal traditions and jealousies. They came and went as they pleased, and generally would not serve outside their tribal area. Their blood feuds complicated their concentrations and actions.

When the Turks easily brushed aside the tribesmen, posted on apparently impregnable positions, it was urged that a more stable and highly-trained and organized force was necessary to resist them, and the idea of creating a Hedjaz regular army arose. The nucleus for such a force existed in the peasants from villages near Medina, who had been driven out by the Turks, and from others near Mecca. At the same time Captain T. E. Lawrence, who was then with Sherif Feisal, saw that the Hedjaz would best be defended, not directly—by blocking the Mecca road—but by getting on the flank and nerves of the Turks. He prevailed upon Feisal to adopt this strategy and, with the assistance of the Royal Navy, to convey his men along the coast to Wejh, about 250 miles north of where he then was. The Arabs entered Wejh on 22nd January, 1917, and found themselves 150 miles behind Medina. (*Plate* I.)

Immediately the Turks became alarmed. In a short time 11,000 men were put to garrison posts along that line, and all danger to Mecca ceased.

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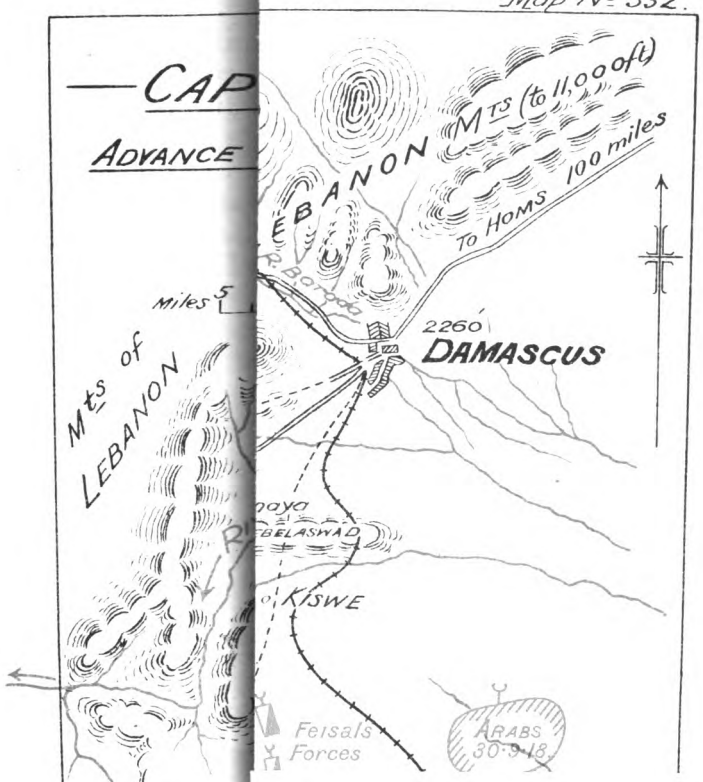
Map No 332.



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At Wejh, the training of a regular Arab force seriously began. Some British and Egyptian officers and N.C.O.'s were provided as instructors, and Feisal's Arabs were augmented by about 1,000 ex-prisoners—Arabs of the Turkish Army—for the most part infantry already trained to the rifle. These were now trained principally to special work, machine and "Lewis" gunners, field gunners, and sappers drilled to demolitions.

During this stage, Lawrence evolved his theory of a warfare adapted to the Arab character, and for ousting the Turks from the Arabian countries. The underlying principle was that the valuable desert Arab should not be wasted in close fighting. His enthusiasm, intelligence and mobility and the fluidity and dispersion of his many tribes should be utilized to harass the Turks far and wide, and oblige them to scatter their strength and waste their material. The more Turks drawn into Arabia, where they could effect nothing, the less Turks elsewhere in the active armies. The Turks in Medina and along the railway were positively beneficial.

Lawrence conceived the idea of attaching to the Arab cause all the tribes up through Edom, Moab and Syria, until there should be set up "a ladder of tribes," up and down which the leaders and their small regular force might move. And each tribe in turn should engage in harassing enterprises against the enemy:—

For the Arabs—propaganda and plunder.

For the Turks—perpetual raids and loss.

The capture of Akaba.—The next step for Feisal's force was to occupy Akaba. The orthodox and obvious approach would seem to be to move by sea, and to land, covered by the Navy, and work up to the plateau of Edom. But, the track up from Akaba to the plateau rises nearly 4,000 ft. and for many miles is at the bottom of a winding gorge only 100 yards wide, and the defile is worse than the Khyber Pass. It was defended by a series of fortified posts, garrisoned by four battalions, with artillery. The Hedjaz railway is 70 miles from Akaba, and 45 miles of the road lie through these defiles.

Lawrence opposed the idea of disembarking on the Akaba beach, and urged that Akaba ought to be taken from the interior. He was told to try his method, and set out in April with a bodyguard of 17 Arabs. He rode 700 miles up country, through Jauf and Azrak, nearly to Damascus, and visited the chiefs *en route*. Lawrence found a tribe of the Howeitat willing to undertake the capture of Akaba, and after adjusting various tribal differences and blood feuds, he came down with 700 men and camped on the edge of the Jafar depression.

Maan was strongly garrisoned, but Fuweila, the post at the head of the defile, was held by a battalion of *Gendarmerie*. Sheikh Wad Abu Tai arranged for the post to be rushed at night, and the garrison were cut up. The defences of the remainder of the posts down the

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defile all faced seawards. The troops depended on a weekly convoy for food; their supplies were cut off, and they all surrendered. Akaba was occupied on 6th July; and Feisal and the Wejh force then moved on there by sea. At this moment Sir Edmund Allenby arrived in Egypt. He welcomed the presence of the Arabs on his flank, and further assisted the development of the Arab Army, which now proceeded to invest Maan.

After the fall of Jerusalem, the task set to the Arabs was to close the gap by which the Turks might move round the south end of the Dead Sea and worry the British flank at Beersheba or Hebron. Also, they were to stop the Turkish grain traffic along the Dead Sea. This they did by capturing the southern port and half the grain fleet—one of the few occasions on which a fleet has been captured by mounted troops.

The recruiting and training of the Arab Army continued all through the summer of 1918. By August, the regulars amounted to about 8,000, with 52 guns (of 17 varieties) and 150 machine-guns. Besides, depôts of arms were formed in the Leja, north-east of Deraa, in charge of the Salut tribe, ready to equip a horde of irregulars.

Up to August, 1918, the only transport, other than the tribal camels in the vicinity, were 700 baggage camels for the Akaba Convoy. But in August, when the Imperial Camel Corps were broken up, 2,000 riding camels were given to Feisal. These were the foundation on which his flying column was built up; and it numbered about 1,000 men in all, distributed as follows:—

450 camel-riding infantry;
100 machine-gunners;
150 Algerian artillery;
4 65-mm. mountain guns;
300 bodyguards, engineers, etc.;
A small party of British R.A.F. and R.A.M.C. personnel.

CHAPTER XI.

EFFECT OF THE GERMAN OFFENSIVE IN FRANCE, MARCH–APRIL, 1918.—Withdrawal of British troops from Palestine for France—Replacement by Indian troops, largely untrained—Local offensives on the Main Front—The Turkish-German attack on Abu Tellul.

EFFECT OF THE GERMAN OFFENSIVE IN FRANCE, MARCH–APRIL, 1918.

WHEN the XXIst Corps had moved to the Wadi Ballut on 12th March, preparations proceeded for a further advance in the coastal sector about the middle of April. But the success of the German offensive in France against the Vth Army, and on the Lys, rendered it necessary to draw on Palestine for reinforcements. The provision of manpower was at an acute stage. It was decided that the Egyptian Expeditionary Force must send as many British troops as possible

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to France, and must expect no more British reinforcements. Only Indian troops and reinforcements could be furnished to fill the gaps. Hitherto, the divisions had been all British, with the 20th and 49th Indian brigades non-divisional. The Palestine front now must adopt the Indian pattern of division, and entirely reorganize its formations.

The first instalment to go was two complete divisions, out of the seven in Palestine. The 52nd Division embarked in the first week and 74th Division in the second week of April. The Yeomanry regiments were withdrawn from the Desert Mounted Corps and replaced by Indian Cavalry. The Imperial Camel Corps was disbanded. One division only, the 54th, was retained on a British establishment. In all others, nine British battalions were withdrawn for service in France, or to be used as drafts. Altogether, 48 British battalions and six Yeomanry regiments and a quantity of artillery were lost to the Egyptian Expeditionary Force.

This depletion temporarily crippled Sir Edmund Allenby's forces, and forbade an offensive on a large scale until the force had been reorganized, and had trained its new personnel.

The reconstitution was effected thus :—

Mesopotamia sent the 3rd and 7th Indian Divisions ; and India provided men for 24 battalions, many of whom had very little training. Six Indian battalions were raised locally by withdrawing a company from each of the 24 Indian battalions already in the force.

The cavalry, perhaps, were the best off, as France had previously released the 5th Indian Cavalry Division and, with the reinforcements from India, these experienced cavalry regiments went to form the 4th and 5th Cavalry Divisions, which replaced the Yeomanry Divisions and Imperial Camel Corps.

From May to early September, intensive training was in progress in all divisions. The new Indian battalions and other units were devoid of specialists; Lewis and machine-gunners, signallers, drivers, etc., had to be provided for three-quarters of the units, and most of these were trained in the field ; and, in view of the great difficulties of language and the lack of experienced N.C.O.'s, it certainly was a remarkable feat thus entirely to alter the organization and composition of an army, carry out its training in face of the enemy, and within five months fit it for a victorious campaign.

Local Offensive Operations on the Main Front.—Although the larger operation, planned for April, had to be cancelled, the XXIst Corps was able to proceed with a limited offensive to improve its line, especially in the hills on the right. Kefr Ain, Berukin, and Rafat, all across the Wadi Ballut, were captured between 9th and 11th April. This enabled the British to use the Wadi Ballut for lateral communications and to benefit fully from the water it contained.

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Again, on 8th June, the XXIst Corps made an advance, but on its left, to secure ground north of Richard I Castle at Arsuf. This gain entirely prevented the enemy from overlooking the British position on the left and gave good observation of the enemy's lines on this flank. The concealment of the ground here was particularly important in view of the use to which it was put in the autumn. On both corps fronts, the Turks were kept busy by frequent minor enterprises, raids and improvements of the British line.

In these operations the newly-raised troops gained experience and confidence. The most noteworthy was on August 12th, when the 29th Brigade raided the El Burj–Gurabeh ridge, north-west of Sinjil. Here, one British and two Indian battalions surprised the Turks on a frontage of 2½ miles. The advance had to traverse 2,000 yards of rocky ground and climb 900 ft. to attack an enemy behind sangars. The Turks were attacked on both flanks and completely surprised, and the raiders returned with 239 prisoners and 13 machine-guns.

The Turkish-German Attack on Abu Tellul.—After the Es Salt raid, the Jordan valley front was taken over by the Desert Mounted Corps, now of four divisions. Normally, one division was down in the valley and the remainder were echeloned back towards Jerusalem on higher ground. The retention of a strong formation in the valley, in spite of the severity of the summer there, accentuated the impression on the Turkish command that the aim of the British was to break out on that flank towards Deraa.

Under German pressure, a serious effort was made on 12th July to overrun the line and deprive the British of essential ground.

On the night of 11th–12th July, the enemy concentrated troops on both banks of the Jordan. A German "Pasha" battalion, and some 3,000 Turks, assembled near Abu Tellul, and another group near Henu Ford. Abu Tellul was attacked and captured at 0330 hours, so that the advanced line of the Desert Mounted Corps at Mussalabeh was isolated; but, although surrounded, the posts held out. Within an hour, the 1st Australian Light Horse Brigade counter-attacked, and by 0500 hours Abu Tellul was retaken; and the enemy, driven back against our isolated posts, lost heavily.

In this operation the Turkish infantry badly let down their German Allies, and left them to execute the dangerous work unsupported. The 1st Australian Light Horse captured 276 Germans and 62 Turks.

The enemy on the left bank fared no better. The Imperial Service Cavalry Brigade was crossed over to forestall the Turks moving on Henu. By skilful use of ground, they got within charging distance and made the most of their opportunity; 90 Turks were speared and 91 captured.

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CHAPTER XII.

INITIAL PREPARATIONS FOR THE AUTUMN OFFENSIVE.—The necessity for training newly-raised units caused the postponement of large operations to the autumn—Railway construction: Light railways, roads—Improvement of communications, Water supply, bases, etc.—Considerations affecting the strategy of the autumn campaign—Numbers and situation of the VIIth, VIIIth and IVth Armies—The plan of campaign—Instructions to the various Corps—Preparations for the attack: Steps taken to mislead the enemy—German appreciation of the situation at end of August—Initial operations by the Arab Army—Attack on Deraa.

INITIAL PREPARATIONS FOR THE AUTUMN OFFENSIVE.

THE strategical plan for the destruction of the Turkish Army was drafted in May, and was then communicated to Corps Commanders. The necessity of training the newly-raised Indian battalions had made it desirable to postpone the offensive operations on a large scale for several months.

The opening of the wet season in November rendered it necessary to complete the campaign by the end of October; so that the middle of September was decided on for the opening moves. (See *Plate* XII.)

The preparations, besides training, dealt chiefly with improvement of communications, accumulation of supplies, and lines of local defence. First of all, the railway from Ludd to Jerusalem was converted from 3 ft. 6 in. to standard gauge—a very difficult task in the mountain section. The Turkish railway from Junction Station to Beersheba was connected to the Rafa-Beersheba branch line at Irgeig, and similarly widened. This gave Sir Edmund Allenby a double track from Rafa to Ludd; and the double line already existed from Rafa to Kantara. At Kantara, a swing railway bridge was built over the Suez Canal. Light railways multiplied immensely on both the XXth and XXIst Corps fronts. On the right, a line was built out from Jerusalem to Bireh. On the left, Jaffa was reconnected to Ludd, and a line taken up nearly to Abud. Another light railway from Jaffa ran north, across the Nahr Auja, nearly to Arsuf. Perhaps the enemy had been misled previously by the light railways on the British left flank at Gaza, but he does not seem to have let their development round Jaffa lead him to suspect a main attack on that flank again.

Road-making was on a grand scale. The Jaffa–Jerusalem–Jericho road, and the Nablus road within our lines, were widened and improved out of all recognition. Four great spur roads were run out towards the front, two in the XXth Corps area, two in the XXIst; and lateral roads were built to cross-connect these. A semi-permanent bridge was built over the Jordan at Ghoranieh, and many masonry bridges over *wadis*.

The port of Jaffa was improved, and the landing of supplies there

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much accelerated. Ludd became an immense supply and ordnance area, with Rafa as an advanced base. But Jerusalem and Talaat ed Dumm also developed very large dumps, and the lorry traffic down the Jericho road was very heavy. Water supplies all along the front were improved; and extensive pipe-lines and pumps laid down to aid concentrations of troops. Much wiring of the line was put in hand to enable portions to be held thinly, when troops should be drawn out to concentrate elsewhere.

The anti-aircraft defence was highly organized, and elaborate arrangements were provided for notifying by wireless the approach of hostile aircraft, with the result that the observation of our lines was rendered extremely dangerous to the enemy; and, towards the end of the summer, his aeroplanes were practically driven out.

Considerations affecting the strategy of the Autumn Offensive.—At the beginning of September, the Turkish forces on the Palestine front were in three Army Groups:—

IV*th Army.*—Headquarters, Amman; 2,000 sabres, 6,000 rifles' 74 guns, facing us east of the Jordan; with a further 6,000 rifles and 30 guns, south along the Hedjaz railway at Maan;

VII*th Army.*—Headquarters, Nablus; 800 sabres, 7,000 rifles, 111 guns; on both sides of the Jerusalem–Nablus road, on a 20-mile front;

VIII*th Army.*—Headquarters, Tulkeram; 1,200 sabres, 10,000 rifles, 157 guns, holding from Furkah to the sea;

General Reserve.—3,000 rifles, and 30 guns, dispersed between Tiberias and Haifa.

Total enemy fighting strength, approximately:—

4,000 sabres, 32,000 rifles, 400 guns.

Ration strength, south of the line Beirut–Damascus, about 104,000 men.

These forces were commanded by General Liman von Sanders, who had relieved von Falkenhayn in February; and who had already fought against British troops in the Dardanelles.

The British and Overseas Forces in Palestine at this time were:—

4 cavalry and mounted divisions;
7 infantry divisions; and besides,
A French contingent equivalent to a brigade group.

Their total fighting strength was, approximately:—

12,000 sabres, 57,000 rifles, 540 guns;

a superiority of nearly two to one over the enemy. (See Appendix III. Orders of Battle.)

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The Arab forces, under Sherif Feisal, were approximately 8,000 fighting men; a valuable adjunct on the flank of the British in an advance.

Sir Edmund Allenby, in his despatch of 31st October, 1918, wrote as follows:—

> "I was anxious to gain touch with the Arab forces east of the Dead Sea, but the experience gained in the raids against Amman and Es Salt, in March and May, had proved that the communications of a force in the hills of Moab were liable to interruption, as long as the enemy was able to transfer troops from the west to the east bank of the Jordan. This he was in a position to do, as he controlled the crossing at Jisr ed Damie. The defeat of the VIIth and VIIIth Turkish Armies, west of the Jordan, would enable me to control the crossing. Moreover, the destruction of these armies, which appeared to be within the bounds of possibility, would leave the IVth Army isolated, if he continued to occupy the country south and west of Amman. I determined, therefore, to strike my blow west of the Jordan."

The whole of the Turkish forces west of the Jordan—except the small scattered reserve—was enclosed in a rectangle 45 miles in length, but only 12 miles in depth, whose northern edge was a line from Jisr ed Damie through Nablus and Tulkeram to the sea. (See *Plates* XI and XII.) All the enemy's communications ran northwards from the eastern half of this line for 25 miles to Afule, or Beisan; and thence eastwards up the Yarmuk valley to Deraa Junction. El Afule, Beisan and Deraa were the vital points of the enemy's communications, to which his front was parallel. If these points could be seized, his retreat would be cut off. Deraa was beyond the reach of the British, but was accessible to the Arab forces moving wide over the desert.

El Afule, in the Plain of Megiddo, and Beisan in the valley of Jezreel, might be reached by our cavalry, if a gap could be made in the enemy's defensive line for them to pass through. It was essential that this gap should be made at the outset of the operations, so that the cavalry should reach the vital points before the enemy had time to man the passes of the mountains of Samaria, leading into the Plain of Esdraelon.

The operations of the XXth Corps, in the hills north of Jerusalem, had proved that an advance of five miles a day was the most to be expected in such mountainous country. A far more rapid and decisive advance than this was necessary, and the easy ground of the Plain of Sharon gave scope for this. Moreover, the approach by the coast would enable the cavalry to cross the mountains of Samaria at their narrowest point; and would facilitate the railway and road developments necessary for the maintenance of an advancing army.

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Such were the reasons for which Sir Edmund Allenby decided to deliver his main attack in the Coastal Plain, rather than in the hill region north of Jerusalem.

The Plan of Campaign.—Briefly, the plan of campaign was to transfer the bulk of the cavalry (to be three divisions) secretly to the coast; to transfer the 60th Division from the XXth to the XXIst Corps, and so, to concentrate an overwhelmingly superior force of infantry and guns against the right of the Turks. It was intended to begin with a short but intense bombardment, then to deliver the assault, create a gap at the coast, and immediately push the cavalry through to capture El Afule and Beisan. Simultaneously, the Arab Army was to attack the Hedjaz railway about Deraa.

The enemy held two lines of defence in the coastal plain of Sharon.

The first, 14,000 yards across and 3,000 yards deep, ran north-west from Bir Adas to the sea, a series of redoubts connected by continuous fire-trenches.

The second line, 3,000 yards further north, extended from Et Tireh to the Nahr Falik; and near the coast the ground was marshy with few crossing places.

When the Desert Mounted Corps (less the Australian and New Zealand Mounted Division) and the 60th Division had assembled behind the XXIst Corps, the British numbers on the front of the main attack were, approximately:—

9,000 cavalry;
35,000 rifles;
383 guns;

to act against

1,200 cavalry;
8,000 rifles;
130 guns.

Instructions to the various Corps, etc.—Lieut.-General Sir Edward Bulfin, commanding XXIst Corps, had at his disposal the 3rd, 7th, 54th, 60th and 75th Divisions, the French contingent, 5th Australian Light Horse Brigade, two brigades mountain artillery and 18 batteries of heavy siege artillery. The instructions he received were:—

(*i*) To break through the enemy's defences between the railway and the sea;
(*ii*) To open a way for the cavalry;
(*iii*) To seize the foothills south-east of Jiljulieh, and then
(*iv*) To swing the XXIst Corps to the right, pivoting on the French Contingent and 54th Division, on the line Hableh-Tul Keram, and advance north-east so as to drive the enemy up the Messudie–Jenin road into the cavalry at El Afule.

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The G.O.C., Desert Mounted Corps had the 4th and 5th Cavalry Divisions, and the Australian Mounted Division. Lieut.-General Sir Harry Chauvel was directed to advance along the coast immediately the infantry had secured the crossings over the Nahr Falik. On reaching the line Jelame–Hudeira, he was to turn north-east, cross the hills of Samaria, and enter the plain of Esdraelon at El Lejjun, and Abu Shusheh.

The Desert Mounted Corps was to seize El Afule and Jenin, send a detachment to Nazareth, leave sufficient force at El Afule to cut off the retreat of the Turks there, and go on to Beisan, and also seize the Mejamie railway bridge over the Upper Jordan. (*See also* page 223).

The XXth Corps, under Lieut.-General Sir Philip Chetwode, now contained only the 53rd and 10th Divisions, who were on the flanks of his position ; the centre was now very thin. He was ordered to advance his right on the night preceding the main attack, so as to place the 53rd Division in a favourable position later to block the exits to the Lower Jordan valley.

Major-General Sir Edward Chaytor, with the Australian and New Zealand Mounted Division, Imperial Service Infantry Brigade, and four unbrigaded battalions (Chaytor's Force) was ordered to cover the British right flank and execute a series of demonstrations in the Lower Jordan valley, to induce the enemy to believe that an attack east of the Jordan, towards Amman or Magdeba, was beginning. The enemy's suspicions that such an attack was in preparation had already been strengthened by every possible means.

The functions of Sherif Feisal's Arab forces were twofold. First, they were to ensure that the Egyptian Expeditionary Force, in its advance, east or north, would be welcomed—not resisted—by the Arabs whose territories it would traverse.

Second, a flying column, consisting at the outset of about 1,000 Arab regular troops, was to assemble at Kasr el Azrak early in September. Thence, it was to cut the Hedjaz railway, and all the enemy telegraphs, effectively, south and east and north of Deraa, on a particular day—not sooner nor later, and keep them cut. Afterwards, gathering strength from the Arab tribes, and arming them from the previously-formed depôts in the Leja, the column was to cover the right of the British advance.

Kasr el Azrak was conveniently situated in the desert, 50 miles east of Amman. If the column were discovered, its presence there would serve also to convince the Turks that a concerted advance on Amman was in preparation.

The object of attacking round Deraa was to draw up there the small available Turkish reserves from Afule : and adherence to the exact date was important, so that the enemy should neither first get wind of the greater attack on the coast, nor have time to get back

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from Deraa to oppose the cavalry who were to break through into the Plain of Esdraelon.

The arrangements with Sherif Feisal were made in the simplest manner. No operation orders, no written instructions. Colonel T. E. Lawrence came over by aeroplane to General Headquarters and there received the personal directions of the Commander-in-Chief which, on return to Fuweila, he conveyed to Sherif Feisal.

The task of the Royal Air Force, prior to the main attack, was to prevent hostile aircraft from detecting the great concentration of troops in the XXIst Corps area. Very early in the morning of attack a Handley-Page aeroplane was to open the offensive by bombing El Afule; and a special bombing squadron was to attack all the other known telegraph centres behind the line, so as to break up the enemy's inter-communication system at the outset of operations.

The Royal Navy arranged to co-operate with two destroyers who were to fire upon any enemy using the road along the coast.

Preparations for the Attack.—The chief difficulty to be overcome was to effect the concentration without disclosing what was afoot. The marches of the mounted troops from the Jordan were effected by night, while the infantry sent to replace them moved by day. Even a practised observer would have had difficulty in detecting the changes, as the Desert Mounted Corps had long had rest camps by the coast, and the roads contained troops moving both east and west.

The Desert Mounted Corps, and 60th Division, when they arrived in the coastal area, were hidden in the orange groves, olive yards and vineyards, between Ludd, Ramleh, Jaffa, and Sarona. Great care was taken in the watering of horses, and in concealing the vehicles, and in using air patrols to prevent enemy observation of our lines.

Elaborate arrangements were made to mislead the enemy in the Jordan valley. The Headquarters of the Desert Mounted Corps at Talaat ed Dumm, in view from the hills in the enemy's lines, remained standing for a fortnight after the Corps Staff had departed to the coast. It was lit up every night, and the wireless traffic to and from it continued with normal regularity, as though the Corps were in the valley.

The thinning of the line behind the XXth Corps was stiffened by dummy camps, complete with transport, horse-lines and isolated parties grazing (all wood and canvas camouflage).

G.H.Q. commandeered and closed the principal hotel in Jerusalem as an advanced report centre. The Staff to occupy it was nominated, rooms allotted, and telephone system fitted up a week before the attack opened. But no one ever occupied it then.

Special steps were taken to facilitate the rapid advance of the

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railway and the supply of the troops on the move. At Rantieh, within two miles of the enemy front line, a railway station and supply depôt was laid down by night, and camouflaged.

The supply of water to troops, when they should arrive about Jiljulieh, was assured by arrangements to lay on a 4-in. pipe-line from the Nahr Auja for six miles on Zero Day.

The enemy knew an offensive was in preparation, he was led to expect it from the east; and, in spite of his captures from patrols during the concentration period, he remained in ignorance of the real direction of the attack.

An appreciation of the situation, exactly three weeks before the blow fell, issued to Constantinople by the German *Liaison* Officer with the Turkish VIIIth Army reads:—

> ". . . . the English will carry out this autumn, like last year, a well-prepared attack, whose strategic objective would be primarily Deraa, and its political objective the occupation of Damascus. (See *Plate* XIII.) In any case, the English will try to tie down as great a force as possible in the coastal sector. . . . . But they will probably confine themselves more or less to demonstrations—just as they did last year at Gaza. They will use most of their forces—attack troops and cavalry in this case—against the country nearest the Jordan, and . . . . they will be able to take advantage of the help of their Arab allies."

As a preliminary step, on 16th September, the Arab flying column, which had moved on to Umtaiye from Kasr el Azrak, attacked the Hedjaz railway, 16 miles south of Deraa, and destroyed a bridge. Next day (Z−2) they carried out extensive demolitions north and west of Deraa. They moved to Tel Arar, destroyed a bridge, and broke every rail for ten kilometres northwards; then they entered Mezerib, on the Yarmuk valley branch, and wrecked the station. (See *Plate* XIII.)

On 18th September, the Arabs crossed again below Deraa, destroyed the Nasib bridge, and caught the construction train at work on their first day's damage. On the same day the Royal Flying Corps heavily bombed Deraa Station. All traffic to Palestine ceased in consequence.

These diversions were highly successful; the German battalion at Haifa was sent up to Deraa on 17th September, and enemy aircraft were diverted to search for and bomb the Arab force.

(To be continued.)

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APPENDIX III.

ORDERS OF BATTLE, SEPTEMBER, 1918.

(Abridged).

(*a*) EGYPTIAN EXPEDITIONARY FORCE.

Commander-in-Chief: Sir Edmund Allenby.

XX*th Corps.*
10th, 53rd, 60th Divisions.

XXI*st Corps.*
54th, 3rd (Lahore), 7th (Meerut), 74th Divisions.
Détachement français de Palestine et Syrie.
Distaccamento Italiano di Palestina.

Desert Mounted Corps.
4th and 5th Cavalry Divisions.
Australian Mounted Division.
Australian and New Zealand Mounted Division.

Palestine Lines of Communication.

(*b*) TURKISH FORCES (YILDERIM ARMY GROUP).

Commander-in-Chief: General der Kavallerie, Liman von Sanders.

IV*th Army* (*2nd and 8th Corps*).
Composite Division, 48th Division, 24th Division.

VII*th Army* (*3rd and 20th Corps*).
1st, 11th, 26th and 53rd Divisions.

VIII*th Army* (*22nd and Asia Corps*).
7th, 16th, 19th, 20th and 46th Divisions.

Cavalry.
3rd Cavalry Division, 2nd Caucasian Cavalry Brigade.
3 German squadrons.
2 Machine-gun Companies.
The German Asia Corps consisted of 3 German infantry battalions, 4 batteries, and detachments of Engineers, and technical troops.

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WITH DIVISIONAL R.E. IN PALESTINE.

A lecture delivered at the S.M.E., Chatham, on 10-11-21, *by* MAJOR AND BT. LIEUT.-COLONEL E. M. S. CHARLES, C.M.G., D.S.O., R.E.

I PROPOSE to tell you this evening of the adventures of the 10th Divisional Engineers in the Judæan Hills from about January 1st, 1918, until the end of hostilities, since time does not permit of my saying anything about the operations from the battle of Gaza—Beersheba up to the capture of Jerusalem. These adventures were in all probability very similar to those of other divisions operating in the hills, but down in the plains the engineers doubtless had different problems to tackle.

I must first of all say a few words on our organization. The division was organized on a modified pack basis, which means that some of the transport was on wheels and some on pack. The equipment of field companies was carried on camels, and in addition to the ordinary equipment each company had special water equipment, such as extra pumps and troughs. All the artillery was wheeled, and the infantry were partly on wheel and partly on pack; their Lewis guns were carried on limbered G.S. wagons, so our first job was to improvise a pack equipment so that battalions could take forward a certain number of guns if they got into mountainous and roadless country.

My field company commanders, I think, preferred being on a pack basis, as it allows of a greater elasticity for work. There are certain disadvantages—for instance, you require more animals to carry your equipment, and this means longer columns on the march and consequently more tiring marching. It also means that the Q.M.G. has far more mouths to feed, and it makes a very serious difference to him.

We had had over a year's experience of pack transport in Macedonia, where our animals were mules, and we were new to camels. For some reason the camel is universally objurgated. I am sure all officers who had anything to do with camels in Palestine will join with me in saying that they have been grossly libelled, and that, when properly looked after, and organized, they are very good military servants. They do not mind shell-fire in the least, and even when wounded, provided a leg is not broken, they carry on as if nothing had happened until they die.

In order that you may visualize the problems that confronted us, I must give you a short description of the country across which we were to advance. The hill system is rather like a fish s skeleton ·

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the backbone, 2,500 ft. to over 3,000 ft. high, runs roughly along the Jerusalem–Nablus road, and a series of spurs are thrown out on either side, those on the west reaching to within a few miles of the railway, and those on the east running down into the Jordan valley which varies from 600 ft. to 1,300 ft. below sea-level. Our own particular bit of country was just to the west of the Nablus road.

These spurs are all, or almost all, steep-sided and are either rocky or drop down in natural or artificial terraces to the water-courses, which are nothing more than narrow torrent beds. Very few of these water-courses had permanent running water in them, nor, even after heavy rain, do I remember them hampering our communications except in one case.

I have not attempted on the map to show any of the hill features, as it would confuse the detail too much, but at certain points I have shown the heights above sea-level of the water-courses and the hilltops or passes.

As regards cultivation, any more or less level patches and the terraced hillsides were planted with either olives or fig trees.

The road and railway system when we came on the scene was simplicity itself. The metalled roads were :—Junction Station–Latron, Jaffa–Jerusalem, Jerusalem–Nablus, Nablus–Tul Keram and Tul Keram–Ramleh, metalled in places. There was, in addition, the track shown from Ludd to Beit Sira, continued up into the higher hills and marked " Roman Road," parts of which were 1 in 4 and could not be improved without prohibitive work. A 13-pounder gun had also been got up to Lower Beth Horon.

These were the only roads passable to wheels that concerned our division.

There is nothing much to be said about the railways, except that at the end of 1917 a single line was working as far northwards as Junction Station.

I shall now ask you to imagine yourselves in the middle of Judæa on the line occupied by the 10th Division at the end of 1917 and the beginning of 1918. Our right, in touch with the 53rd Division, was just to the east of Harasheh (marked 2500 in the map), the highest hill in the neighbourhood, and our left at Deir El Kuddis, in touch with the Australian Mounted Division. We had succeeded in reaching this position, after two or three days' fighting, from a general line through the two Beth Horons. In front of us we had no roads at all, and behind us our communications north of Beit Sira were of the most exiguous nature. We had a battle road from Suffa to Ain Arik, with a branch up the Wady Sad. There was also a gun-track from Lower Beth Horon running up the spur south of Ain Arik and ending nowhere in particular—its sole object had been to enable guns to get within range of the Nablus road in the course of the fight and shell the retreating Turks, and this it accomplished—but as a

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feeding road it was useless, being too steep and narrow, and it did not run in the required direction. To show the nature of the native tracks I might mention that in the course of the fighting, during which we made use of donkey convoys to carry up food and ammunition, at certain places we had to place parties of men to lift the donkeys over the bad places. There was no direct communication with the division on our right, and if the Corps Commander wished to reinforce either flank, the only road was *via* Latron and Jerusalem.

It was therefore of prime importance to improve our communications rearwards and to make lateral roads for wheel transport within our Corps, and to do so as economically as possible.

The lower part of the Wady Ain Arik carried a lot of water after rain, which washed away our road, such as it was, so it was decided that the line of the permanent road after leaving Suffa should run up the Wady Sad valley, and then drop down to the village of Ain Arik, thence up the valley, and so on to Ram Allah, the division on our right working to meet us from Ram Allah. This road was christened "Irish Road."

As regards road construction, our infantry had had a good deal of experience in Macedonia, so different portions of the road were allotted to different battalions and they did the entire work, with the exception of culverts and any retaining walls required, which was done by the sappers. A spirit of competition was set up and all the officers, from the C.O.'s downwards, were as busy as bees. The pioneers were employed on special stretches where skilled labour was required—two companies blasted their way down from the elevated valley of the Sad into the Ain Arik valley, and another was employed on the zigzags necessary to drop from Suffa into the main watercourse.

Stone throughout was plentiful and handy, but had to be sorted out from a lot of worthless stuff. All metal and soling had to be carried by hand, since wheeled traffic could not be used except in a very few cases. It was found that in favourable circumstances of stone being handy—say, not more than 100 yds. carry—a daily rate of progress of 2 ft. per man of road, 12 ft. wide, could be made, and this was made the task where applicable. It was often exceeded by the road being made 14 ft. wide and the same progress maintained. After the first 3 in. of metal had been worked in by the traffic, a second coat was added, and in spite of the rapidity with which the road had been made, it stood lorry traffic well. A steam-roller was a luxury beyond our means. A 12-ft. road as a main communication is a constant source of annoyance. Traffic is much delayed by having to wait at passing places, and moreover, a narrow road requires more constant upkeep than a broad one, so, as soon as communication was through, the road was widened throughout to 18 ft.

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At this juncture I should like to say a few words on road gradients. I once made a resolve that I would never have a road steeper than 1 in 15 in Palestine, but I am afraid that good intention has gone to pave the roads in another place. It is all a question of time and labour available, but if in a mountainous country you can keep your ruling gradient to 1 in 10 with the labour at your disposal in a division, you will be lucky. One of my main roads, after rising 1,000 ft. in about 5 miles, finished up, I regret to say, with a 50-yd. stretch of 1 in 7½, and I was never able to get labour to improve this last part. Our train did the trip fully-laden, day after day, and never seemed any the worse for it.

To revert to our situation in the Judæan hills, other roads were made, besides all sorts of tracks up to battalion and company headquarters. The fourth company of pioneers also started on a road from Beit Sira northwards. My idea was that any advance must be made in this direction, and also the road would help in feeding our left.

Turning now to the water situation, we were in clover compared with what we had been up to Christmas. In the Beth Horon position all our personnel in front of D.H.Q. had to rely on water in cisterns round the different villages. As the cisterns got empty new ones had to be discovered, and the inhabitants cannot be blamed for not helping us, as we were drinking up all their water. Horse lines had to be kept miles in rear at Yalo or Latron, so horses required at or in front of Brigade Headquarters could only water once a day on account of the distance to water. Now, however, our right and centre were well off with large springs near Ain Arik and Ain Kanieh, and running water at the foot of Harasheh. Our left, at Kuddis, still had to rely on cistern water, but there were some very large cisterns there and not many inhabitants.

As for defences, the rocky nature of the ground prevented all digging, and the railway was not working sufficiently well yet to be able to bring up any R.E. material. The defences consisted solely of stone sangars, which the infantry soon became adepts at building. The nature of the country permitted the front line being held entirely by observation by day; indeed, this continued right up till the final advance in September.

In the course of February our organization was changed, and we reverted entirely to wheel transport, but whenever an advance was contemplated our train was reinforced by companies of pack transport, either camel or donkey, so that we should always be sure of getting our supplies even if we could not make roads.

Before January was over reconnaissances were pushed out to see how best our advance could be continued. On our right you will see from the heights shown on the map that the country was impossible for a main supply road. Starting from our left we found a good

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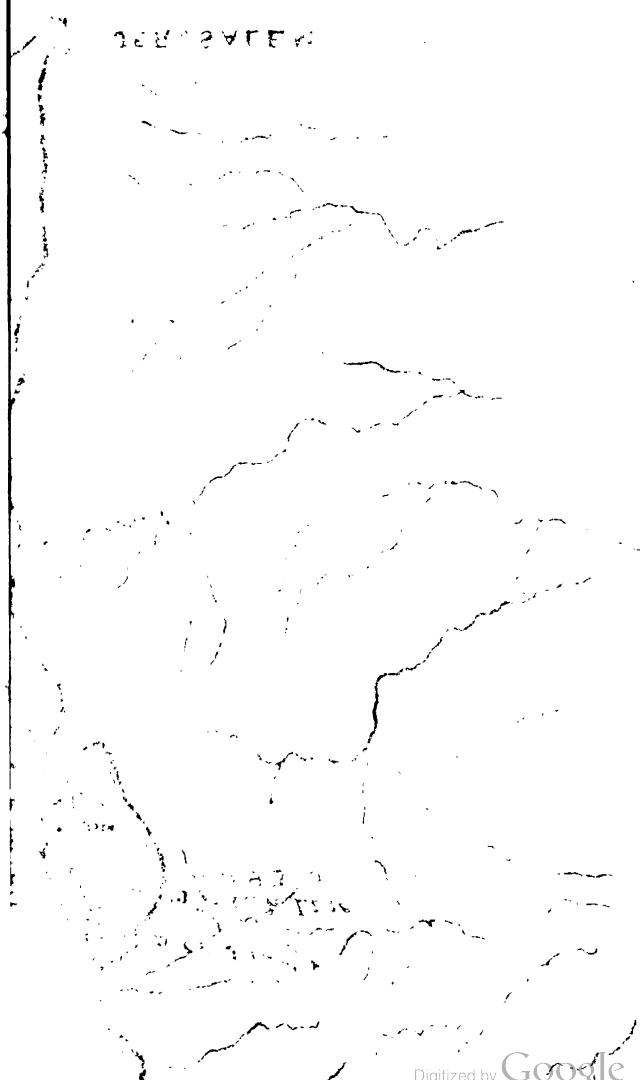

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alignment from Beit Sira to Job's Well, thence one branch up to Beit Ello and another up the Wady bed to Shukheidin, and thence round point 2665 to Bir ez Zeit, although this latter road was steep in parts. On February 1st therefore work was started in earnest on what was called " The Great North Road " from Beit Sira to Harith, with orders to have it finished and ready for lorry traffic by March 1st. Eight battalions, in addition to the pioneers and one field company, were at one time working on it, and the same system adopted as on Irish Road. As, however, the road was made 18 ft. wide from the start and was much more carefully made, such rapid progress could not be expected, and as a matter of fact the progress did not average more than 4 in. to 6 in. per man per day. Additional reasons for the slower progress were that the formation was more difficult, the soling was more carefully built, 6 in. of metal was put on in two layers instead of a single layer of 3 in., and rammed in by hand-rammers, and " water-tables " and side-drains made. The pioneers' portion was from the Wady crossing at point 713 northwards for about three-quarters of a mile, involving a good deal of blasting, retaining walls and zigzags to gain height. By February 28th the road had been continued 1,200 yds. beyond Harith, and all but two battalions were taken off for other work. These two battalions, together with some companies of pioneers, continued the road as an unmetalled one, and eventually joined up near point 2665 (except for certain portions in enemy view) with a track that had been made from Ain Kanieh. Other parties had also been at work on a road from Job's Well to Beit Ello, but the continuation of this road involved labour beyond our resources at that time.

While this road-making was going on an outpost line had gradually been pushed out for the protection of the road-makers.

The plan for our next advance was for two brigades to advance northwards, one roughly each side of point 2665 and the third to advance from the Beit Ello direction. The objective was the ridge Jiljilia—Arura and thence to Beit Rima. Owing to the difficulties of communication the left brigade was practically a detached force, and as such one field company was put under its brigadier.

The roads required for the battle were :—

(1) The completion of the Harith—Bir ez Zeit road.
(2) A track towards Attara, to enable guns to advance to the support of the right.
(3) A track branching off from (2) to allow guns to advance to the support of the centre brigade.
(4) A track branching to Umm Suffa to allow guns to advance and support the attack on Arura.

The troops allotted were :—

No. 1. Two Cos. of pioneers.

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No. 2. One Fd. Co., R.E., and one Co. pioneers. The Fd. Co. was also to look after the water supply of the right brigade and divisional troops.

No. 3. One Fd. Co., R.E., which also had to look after the water supply of the centre brigade group.

No. 4. One Co. pioneers with such infantry as might be allotted. The allotment to No. 1 was perhaps rather excessive, but I felt that later on it might prove difficult to bring back labour on to this road, which was our main line of supply.

The road programme was carried through as intended. The Attara party got shelled from time to time, but carried on. The pioneers on the track to Umm Suffa had a difficult job getting off from the hog's-back ridge which runs from Bir ez Zeit to Point 2791. By eleven o'clock I saw they would require assistance, so sent back a message to D.H.Q. for the divisional reserve of two battalions to be sent up, along with my pontoon wagons, which had been loaded up with road tools. By the time these troops arrived a route had been reconnoitred, so they were marched straight on to the work in the order in which they arrived. To a Sapper, one battalion is very like another, but to the Staff, it makes a difference as to where particular battalions work, and delay was caused by having to change the battalions round. (*Moral*—Consult the Staff beforehand as to their wishes in the matter). It was 11 p.m. before this road was finally through, owing to one of the battalions being required for fighting shortly after it started work.

The brigade of artillery that used this road had a trying day. They came into action in the early morning near Beit Ello, and to get into their next day's positions they had to go back to Job's Well and then on to Umm Suffa *via* Bir ez Zeit, since a crossing over the Wady Zerka was estimated to be an eight-days' job for 800 men.

The following day the battle continued for the possession of the north side of the Wady Jib. The R.E. and pioneers spent the time improving the sketchy communications and searching for a practicable road or roads across the Jib. In this connection I want to bring forward an instance of the *liaison* that ought to exist between a field company and the brigade it is helping, even though it is not under the brigadier's orders. Both D.H.Q. and I received reports respectively from Brigade Headquarters and the field company as to the possibility of a road down to the Jib and the amount of labour required. Of course, both messages were made out by the field company, but the point is that Brigade Headquarters were then warned and so had troops earmarked, and were ready to start work on the word "Go" from D.H.Q. On a previous occasion I had received an equally good report, but apparently the brigade had been out of touch with an R.E. officer, for they were taken by surprise

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when D.H.Q. ordered them to provide the labour, and this surprise resulted in avoidable hardship on the infantry. Meanwhile an exceedingly steep track was made down to Ajul, and pack tracks improved or new ones made from Beit Ello to Arura. On the right a way was found up to Jiljilia, but it took two battalions, two companies of pioneers and two sections of a field company five days to make. The hillside was so steep and rocky that in places men were employed solely in holding up those who were drilling the holes for blasting. The gradient of this road was 1 in 10 throughout most of its length.

Further roadmaking from the position we then held seemed so hopeless that for the time being an advance on wheels was postponed and our attention was turned to improving our communications. We actually did get out a scheme for improvising pack equipment to enable one brigade group to go forward, but this was knocked on the head by our having to send nine out of our twelve British battalions as reinforcements to France and elsewhere, these battalions being replaced by Indian battalions.

By the middle of March the last rains had cut up our main line of supply so badly that lorries could not get within eight miles of D.H.Q., and we had to send back two battalions, some pioneers and some sappers to work on bad bits of road as far as eight to ten miles in rear of D.H.Q. We had a certain number of local inhabitants at work, but they were not much good. Our lateral communications were improved by a branch to the Nablus road from Bir ez Zeit, and a new alignment from that village to Umm Suffa, defiladed from enemy view, was made and continued to Neby Saleh and eventually linked up to Beit Ello; tracks were also run from Neby Saleh to Beit Rima and Deir Ghussaneh, as well as various other tracks to suitable gun positions. A road was eventually made from Umm Suffa to Arura, necessitating a good deal of screening from enemy view, and later on this was continued to other gun positions.

You will notice that we had no road communication with the corps on our left. The first one to be made was what might be called a tactical track from Beit Rima westwards, and later on a battalion of Indian pioneers made a more sheltered road from Neby Saleh to Abud. Part of this road was made by an Egyptian Labour Corps company and I was so short of officers through sickness and other causes that I had to put my medical officer in charge of this, in addition to his other duties.

Our division was well off for water in spite of living on the mountain tops, even after various winter sources had dried up. There were anxious moments, of course, as native reports as to which springs diminished or dried up and which did not were untrustworthy. One spring that I was assured never diminished fell from 2,000 to 300 g.p.h. in a week. All springs were measured carefully every Monday

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morning and records kept, so that our fingers were always on the water pulse.

Our right was watered by three or four groups of springs between Attara and Bir ez Zeit, some of which had to be piped down to convenient places. Our centre relied on a large spring near Ajul for forward positions and two more in the Wady Darah for horse lines, etc. One of these was in an inaccessible spot, and with some difficulty a small engine and pump were man handled down a steep hillside to it. It was in enemy view, as was also the rising main, which once got cut when the enemy were searching for a 6 in. battery. Besides watering many hundreds of horses and several battalions and other units from two watering points about a mile apart, the overflow of the spring formed a good bathing pond much appreciated during the summer.

Our left was not so well off but had three or four groups of springs round Neby Saleh. The principal group, Ain Reiya, was the only one at which there was space to water horses, and only gave 800 gallons per hour when we arrived in March. By searching for all the sources and piping them together into a reservoir we were able to utilize every drop of water. In this connection I was able to arrive at a rough rule for calculating the loss by soakage if the water ran over ground instead of in pipes, and in this particular soil the flow of a spring diminished by one gallon per hour for every yard it flowed over ground—thus a spring yielding 100 g.p.h. at its source ceased to have any flow 100 yards from its source. Of course, this rule does not hold for all kinds of ground.

Most of the horse lines for the left of our division watered in the Wady Zerka, where there was a plentiful supply. There was also a good supply at Beit Ello which required a pump and pipe line, where our troops in training watered, and our train watered a couple of miles in rear of Bir ez Zeit.

It is a great advantage to have several different water points, as when more than 300 or 400 horses water at one point you get a lot of congestion, more especially in hilly country. Also when there are a lot of watering points, units are more careful, as they get to look upon the watering place as part of their camping ground.

While on the subject of water I should like to impress on young officers the importance of an elementary knowledge of geology. My own ignorance of the subject was a great drawback to me. I do not know if geology teaches you also to know how to increase the flow of a spring, but I do know that in some cases it is possible to do so, and in other cases not, and the knowledge you want to acquire is to know where labour can be profitably expended.

Also, while on the subject of water, I want to mention the expedient adopted by the C.R.E. 74th division. His division had advanced alongside ours and were badly off for water. They had a good spring in one place, but it required a pump and engine, and it was quite

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inaccessible to wheels, so the C.R.E. went to the Air Force and borrowed a sausage balloon, tied it to the pump and engine and walked away with the whole bag of tricks to the spring.

It was rarely possible to dig anywhere, so the defences consisted of stout stone sangars, about 4 ft. thick at the top. They were never occupied by day, as they were on forward slopes, and at night the garrisons were usually working; eventually we had a double belt of wire entanglement across our entire front and, in addition, in places there were thick blocks of entanglement. On the reverse slope was a line of strong points, also wired and connected together by entanglements, and on the south side of the Jib was a line of defended localities, the villages of Attara and Deir Ghussaneh being put in a state of defence. A rear system was also started from behind Bir ez Zeit to Deir en Nidham.

In various places we built covered gun emplacements, some 30 being specially built for a raid on the El Burj ridge in front of Jiljilia. Owing to lack of girders we could only make the roofs splinter-proof, but the intention was as girders became available to make them 5·9 in. proof.

In August it was decided to have a large raid by night on the Turkish position on El Burj. There was a No Man's Land 2,000 yds. wide and 1,000 ft. deep in places. The idea was that a battalion should penetrate each flank and other parties then mop up, joining hands in the middle. Routes had been reconnoitred by various patrols and as far as we could see the Turkish wire entanglement would be a nasty obstacle if the guns failed to cut it, or if the infantry failed to hit off the exact spots cut by the guns. Another difficulty was to let all the troops know exactly when to return and to ensure that they returned in the right direction and did not penetrate further into the Turkish lines. To help the infantry over the wire we made several bridges out of bamboo and wire netting. Each bridge consisted of a sort of stretcher about 6 ft. long, which was meant to rest on top of the wire, and a second stretcher about 12 ft. long hinged to the first, which acted as a ramp. The wire netting was covered with a grass-filled mattress. The infantry reported very favourably on them after the raid.

On their outward journey the infantry unreeled tracing tape so that on their return they could follow it back.

The signal to return was to be the lighting of a bonfire, whose glow would also give the raiders the direction to make for if they could not find a tape. The bonfire was lit electrically by a sapper who was in telephonic communication with the brigadier. There were also two other bonfires which were to be lit as soon as the first one was seen to be alight.

We also prepared various devices to distract the enemy, such as rows of electrically-lit torches in different places and a series of gun-

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cotton slabs arranged to represent the firing of a six-gun battery, but the Turks were so distracted by the raid itself that they required no other distraction.

Preparations were now being made for the final battle. The general idea, as you doubtless remember, was for the infantry down in the Plain of Sharon to make a break through and for the main force of cavalry to gallop for the valley of Esdraelon and close the roads through Nazareth and Beisan, while the only other outlet, *viz.*, across the Jordan at Jisr ed Damieh to Ammam was to be closed by another mounted force on the extreme right. To ensure the break through on the left, the XXth Corps was reduced from three to two divisions, 10th and 53rd, and our task was first to pin the enemy in front and then to capture as many as we could. A frontal attack, besides bringing us up against strong positions, could only have the effect of pushing the enemy backwards along his line of retreat, so the two divisions were to sidestep outwards, leaving a gap of several miles, and then to converge on Huwara, by which manœuvre it was hoped to bottle up a good many Turks.

The divisional plan was for an attack by two brigades, the right one directed on Furkah and Selfit, and the jumping-off place was near Berukin.

The first thing to be done was to make a good road down to this place from Neby Saleh, since it was impracticable to continue the road from Deir Ghussaneh. As all our guns and most of our transport would be moving down this road while wounded were being evacuated, it would have to take a double line of traffic.

The results of reconnaissance for a road forward from this point were not encouraging, and it was finally decided to make our battle-road up the Wady Mutwy to join on to the Turkish track which ran down that Wady for a certain distance. It was quite impossible to reconnoitre this route for any distance without fighting, and we did not wish to attract so much attention as fighting would entail. As, moreover, our part of the battle was to start at night, you can see that there was a decided element of chance in the success of making a road by night along an unreconnoitred route.

The labour at my disposal, in addition to three field companies, consisted of two battalions of infantry. Of the three field companies one was kept in reserve; one section of each of the other two was told off for water duties for each of the two attacking brigades, and a second section of one of these was told off to accompany a battalion that had a very difficult cross-country march to do in the dark, so as to be able to help it. The remainder of the companies were on road work. As regards the infantry, to avoid the confusion of leap-frogging companies of two battalions forward in the dark, one half of the road was allotted to each battalion, the second of which, of course, could not start work until the ground was captured from the Turk.

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The hour of starting work of the first battalion had to be arranged so as not to interfere with the assembly of troops for the attack, and for the second battalion we had to make a guess as to when the ground would be captured. As it turned out we were not quite optimistic enough.

I interviewed all the officers of each battalion and explained to them exactly what was required, told them the arrangements, and laid stress on the fact that what we wanted was not a road but a track along which guns and transport could go once only, but we wanted that track quick.

For our previous battles I had made various kinds of signalling arrangements for getting back R.E. information during the progress of the battle, but none of them had been satisfactory. This time I made others, including a private telephone line, but I am reluctantly convinced that the surest and quickest way is to rely on the individual who has facetiously been termed a " runner."

The attack started at 7.45 p.m. on September 19th, and went quicker than was expected, as the XXIst Corps had been so successful in their attack that they had completely broken through. However, advancing over mountains in the dark is slow work and road-making in the dark is slower still. By six in the morning we had joined up a very rough track to the Turkish road, but it was some hours before it was improved sufficiently to ensure that wagons would not break any wheels in going over it. The valley had received a certain amount of shelling during the night, but fortunately for the road-making parties all the shells were bursting up the hillsides. The Turks, who had not made a long stand at Furkah, put up a good fight on the Haris–Iskaka ridge and kept us there all day, denying us the use of the Mutwy–Selfit road on which we had counted. The only artillery support to an advance from Selfit could be given by the guns at Arura, at extremely long range, so at three in the afternoon we started on a track from the Ain Mutwy up the valley to Selfit. Our infantry, who had worked all night and well into the day, were too tired to be put on to this work, so I turned on some Egyptian Labour Corps whom I had begged from the Corps that morning ; the track was completed by 6 p.m.

At about 5.30 p.m. the Divisional Commander received a message from the Corps Commander to the effect that the cavalry mass were well on their way to blocking the Nazareth and Beisan roads—that the 53rd Division on our right were held up by appalling difficulties of the country, and the cavalry on its right had accordingly been unable to shut the door at Jisr ed Damieh. We were therefore to push on at all costs and block the road from Nablus to Jisr ed Damieh.

The division accordingly resumed its advance at 11 p.m., two brigades one behind the other, along the Selfit–Iskaka road and the third *via* Jemmain. The Turks had been turned out of the Haris

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position and the division pushed on to about a mile south of Huwara. Here the reserve brigade took up the running on the morning of September 21st.

The Iskaka road, which had been reported as capable of all kinds of traffic in dry weather, was the worst track I have ever seen—narrow, no possibility of getting off it, and with great rocks the size of an armchair sticking up. I do not know how the guns and transport got along it at all, but they did, as did also the Ford cars. The sappers could not do much to improve it as nothing short of blasting would have made any real difference, and blasting would have meant too much delay.

At Huwara is a sudden change in the country, there being a plain about a mile in width running up to Nablus. On the west side the hills are high, culminating in Ebal and Gerizim; on the east side they are low but gradually increase in height till Neby Belan is reached.

From a point about a mile south of Huwara the Divisional Commander had seen the tantalizing sight of dense columns of transport moving along the road to Kh Ferweh, out of reach of his infantry.

Up the Nablus plain the 30th Brigade advanced in their race for Neby Belan; the rear battalion, who had been much delayed by the transport on the Iskaka road, ran for three miles in order to rejoin the brigade and be in at the death. There was no serious opposition in front, but all along the plain they were fired into by machine-guns on the hills on each side. By about midday they had reached Neby Belan.

The heavies, which turned up in tow of motor lorries soon after the start of the infantry, went into action and tried to block the Ferweh road by shell-fire, but the Air Force were on the spot and relays of machines bombed this road from eight till twelve. This road drops down from the Nablus plain by a very steep track cut out of the hillside and forms a defile some three miles long west of Neby Belan; the road also forms shorter defiles at intervals towards Jisr ed Damieh and Beisan and every one of these defiles was a tangled mass of guns, lorries, motor-cars, wagons and dead animals.

The last road was thus closed, and in the next few days the prisoners who surrendered amounted to 5,400. The amount of booty that fell to the 10th Division and the Corps cavalry regiment was: 131 guns, 1,392 wagons, 97 lorries, 32 motor-cars.

Our fighting had come to an end.

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COLONEL BOND'S CRITICISMS: A REPLY.

By CAPTAIN B. H. LIDDELL HART.

OWING to the courtesy of the Editor I am enabled to reply to the somewhat violent attack made by Lieut.-Colonel L. V. Bond, R.E., in the current (September) issue of the *R.E. Journal.*

I regret that his criticisms are purely destructive; it would have been more helpful " to all who are training for war "—to whom I am regarded as a public danger—if Colonel Bond had proved his possession of constructive faculties. Moreover, his criticisms of my " flapdoodle " are couched in language so strong at times that I am tempted to wonder if Colonel Bond has forgotten that " abuse is no argument." Possibly, however, he is acting on the old adage, " If you have no case, abuse the plaintiff."

The object of all of us, I hope, is to get at the truth which lies hidden behind the mass of facts and theories. Unprovoked violence is scarcely a helpful method of criticism. For one who criticizes parts of my writings as " a handful of jargon strung together on an argument of amazing inconsequence " ! I humbly suggest that he might in his own criticism have kept more to the point. Out of an article of some 480 lines approximately 340 are unconnected with any definite points of criticism.

I had hoped for some really helpful criticism which would take us a further measure towards the common goal of all students of war—*truth.* One who wanders so repeatedly from the path is scarcely likely to be a useful guide.

To ascend, however, to the purer air of abuse-free argument I would point out that my theories are directed primarily to warfare against a civilized enemy, in the course of which I suggest a normal course or choice of courses of action. In so discussing the principal form of warfare I only follow the example of F.S.R., which bases its doctrine on a similar foundation, relegating to a subsidiary chapter the discussion of warfare against an uncivilized enemy. If I have erred, I have at any rate done so in good company. I pretend to no knowledge of the latter form of fighting. Yet it would appear that my ideas are not so unsuitable to such conditions by the fact that the General Officer Commanding a Division and District on the N.W. Frontier reprinted my original R.U.S.I. lecture (similar to that given at the S.M.E.) in pamphlet form for issue to the officers under his command, and that my own reprint in booklet form (*Framework of a Science of Infantry Tactics*) was ordered by

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a considerable number of commanding officers in other commands in India for issue to their officers. This, I think, proves that Colonel Bond is somewhat presumptuous in arrogating to himself the right to speak on behalf of all senior officers, even in India. Colonel Bond speaks of my "confident and oracular tone." I am almost inclined to suspect that he is deficient of either the sense of proportion or humour. For "a confident and oracular tone" surely some of his own phrases would be difficult to surpass :—"I do not say that he is invariably wrong," "It will not carry conviction," "No one will be found to dissent from this proposition," "Equipped with the purely mechanical system of Captain Liddell Hart we court defeat in nine cases out of ten," "Captain Hart has attempted to dope us with flapdoodle of the most misleading kind." Whilst I made no attempt to prescribe for Indian frontier conditions, Colonel Bond has no hesitation in speaking in confident terms of the European theatre of war; which, so far as I understand, he never saw.

This brings us to a further point of his, on which he lays great stress, that all theories put forward should be based upon personal experience. One is reminded of the old-time general who based his claim as an authority on war upon the fact that he had seen so many campaigns, whereupon Marshal Saxe pointed out a mule which had been through even more and "was still a mule at the end." The experience of a single individual, or even of a number of individuals, is a very inadequate test! My own small experiences as a platoon and company commander in France were, I freely admit, far less than those of many others—even less a foundation, possibly, than those of a senior R.E. officer on which to build a theory of infantry tactics. They were, however, sufficiently painful to show the defects of the existing tactics.

Colonel Bond forgets that the independence of a regimental officer of infantry is restricted in considerable measure by the existing tactical doctrine laid down by the higher command, and that he can scarcely obtain a free hand for the conduct of extensive experiments. On the other hand, few can appreciate more directly the disadvantages of the existing system.

I can, however, conceive of no editor of a Service journal being able to afford from his limited space sufficient to set down in detail the quantity of data from which even my humble theories were gradually built up. To give one or two isolated experiences of my own or of others might be interesting, but from the point of view of serious scientific investigation affords no practical test.

Colonel Bond is so anxious to find any stick to beat me with that, whilst in one place he calls for my personal experiences, in another he, rightly, points out that any science of tactics must be founded not on individual, or even on multitudinous personal

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experiences of any one time, but on universal experience as contained in history.

This universal experience is the foundation on which in the first place I built up my framework of principles. If he chances to see the *United Service Magazine* for April, 1920, or the *National Review* for June, 1920, he will find some indication of how first I endeavoured to discover and formulate the universal principles. For this purpose I examined both the elemental factor in all war—man—and tested the principles disclosed in individual combat by the campaigns of military history, a few of which I sketched, though necessarily briefly owing to limitations of printed space.

Whilst principles are eternal, the form of tactics in any age vary with the available weapons. But I maintain that if the weapons and organization existing at any one time be tested by these principles, we shall be able to deduce the tactical methods which are suitable to the current conditions.

In the forthcoming second edition of my book (the first having been exhausted by the demands of those who do not find it all "flapdoodle") I have enlarged it in order to trace how, by applying the principles in the form of a test to each successive problem, a normally correct solution or alternative solutions can be evolved for warfare against a civilized enemy.

Let us now examine the few concrete criticisms which Colonel Bond puts forward.

3.—Colonel Bond appears to regard racial characteristics, rather than the actual weapons, "guns, rifles, or tanks," as the true source of tactics. History hardly bears him out. The main tactical developments in history have surely been the product of new weapons. "Changes in tactics have usually followed changes in weapons." Gunpowder, the musket, the shell, the magazine rifle, the machine-gun, the quick-firing field-gun, the tank, have had a very similar effect on tactics among whatever nations they were used.

Personally, I should prefer to say that the tactics of any period must be based on human nature as affected by the weapons of the day.

If we followed out the implications of Colonel Bond's half-digested theory, we should have a distinct tactical doctrine and a different manual for south country regiments, north country regiments, London regiments, Scottish regiments, Australian regiments, Sikh regiments, Gurkha regiments, etc., not forgetting Irish regiments. What a prospect!

Colonel Bond first criticizes the omission of the human factor from my lecture, and then admits that in the *National Review* I deal fully with it. Does he realize that there is such a thing as limitation of space in a journal? In the one I deal with what may be termed

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the mechanism of action, whilst in the other I deal primarily with human nature, on which I founded my theories, and only briefly sketch the mechanism deduced from the former study. As he has read both, it might have occurred to him that a single lecture is inadequate for the treatment of both source and deduction. To paraphrase an old proverb: Half a loaf is better than the unbaked dough.

4.—From my own small experience I have discovered that "the men" are capable of more intelligent action than their leaders often give them credit for. On the Somme, in 1916, when the serried waves imposed by authority broke down under machine-gun fire, the men often coalesced into natural groups and settled German machine-gun nests by manœuvre, which is, after all, but a form of stalking, a natural reversion to the elemental hunting instinct.

5 and 6.—Colonel Bond speaks of the influence of changing conditions on the tactics to be employed.

May I point out that I emphasized that my framework was a "flexible" one, to be adapted to ground and weapons; that I dealt with its "broad application" only.

He picks out two points for criticism—the "maxim" that the leading sections should always send ahead a pair of scouts, and the "maxim" regarding the position of the battalion commander.

Both are accepted in *Infantry Training*, 1921, so that presumably infantry officers of experience approved of them. The distance that the scouts are to be ahead is intentionally left undefined. I would, however, point out that I adopted this particular "maxim" in some measure because I found it universal. There is much to be said for the argument that a section is so small, such an insignificant target, and so controllable that it does not need to move with ground scouts ahead.

7.—If Colonel Bond had read my writings with more care before launching his counter-attack, he might have discovered that, unlike him (See March *R.E. Journal*), I never use the phrase "soft spot tactics," for the simple reason that I regard the "*fix and manœuvre* tactics" as an advance upon the former, in that the idea of *fixing*, if properly fulfilled, does away with the danger of the original soft spot tactics—a weakening of the will to close with the enemy. Nevertheless, even with this inherent danger the original soft spot tactics of 1918 were a vast improvement on the former tactics of piling up the reinforcements, and incidentally the dead bodies, in front of the enemy's strongest points. Does Colonel Bond advocate a return to this latter method? He is careful to keep any ideas that he may have nebulous, so that they can only be guessed at by inference.

Can he honestly contend that my exposition of the act of *fixing*, either in the man-in-the-dark simile or on page 179 of the *Journal*

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for April, 1921, gives the slightest encouragement to any action, or lack of it, which would give rise to "bodies of dejected men roaming about, looking for a soft spot or platoons contentedly held up"? I would refer him also to Maxim 1 of the "Expanding Torrent" method.

Surely, I have sufficiently emphasized that *continuous* and *direct* movement forward is necessary to fix the enemy, that fire alone will never succeed? (I suggest that there is a greater danger in the prescription of the authority whom he quotes on page 162 that "fire should always bring about a decision at a range of from 100 to 150 yards without it being necessary for the infantry to assault.")

The essential point of difference between these *fix and manœuvre* tactics and the old is that, whilst in both it is the duty of the forward sub-unit to press on relentlessly to gain the objective, in my "flapdoodle" theories the supporting sub-unit is used to manœuvre when the former's rate of advance is delayed instead of merely increasing the target and the casualties by direct reinforcement.

The French infantry regulations point out, and I think most infantry officers will agree, that in any advance the leading groups form a very irregular line (even before any definite soft spot is discovered) presenting salients and re-entrants.

By taking advantage of these irregularities, the manœuvre bodies of the less quickly advancing forward units can bring flanking fire to bear on the resistance opposing the forward body of their unit, and ultimately outflank it.

In passing, may I suggest that Colonel Bond is not entirely free from "the infection of catchwords." His "objective outlook" covers a multitude of subjective preconceived prejudices.

8.—When I speak of "modern conditions" I refer essentially to the magazine rifle, the light automatic, and the machine-gun, none of which are now confined to the Great Powers.

Colonel Bond kindly informs me what I meant by "modern conditions." The dogmatic complacency with which *he* explains, quite wrongly, what *I* meant, is quite delightful.

9.—The above misinterpretation naturally invalidates his argument in this paragraph.

10.—I suggest that there is a vast gulf between the "absolute form" spoken of by Jomini and a flexible framework.

It is the difference between the skeleton or bony framework of a man and the complete man clothed in flesh and blood. The conditions of life are such that hardly any two men resemble each other, yet at the same time every man's skeleton is composed of bones which correspond in number, position and relative function.

Jomini, moreover, refers to the major operations of war. These vary so greatly that only the main bones of the framework apply in every case. But in a large action, it is the opinion of many with whom I have discussed the question, that the various situations

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and phases of battle met with by most of the infantry units have a very considerable similarity.

A study of military history seems to confirm this conclusion as regards the small sub-units. If this conclusion is accurate, it surely cannot be denied that the major framework can be enlarged to comprise more bones, without falling into the opposite danger of being rigid in detail. There is still a vast difference between a complete skeleton and a complete body, such as the precise and detailed systems of the past which Colonel Bond rightly anathematizes.

12.—Colonel Bond's criticisms in this paragraph are based on the mistaken assumption that I deduced the actual details of execution from the " man-in-the-dark " or the " expanding torrent," whereas in reality I only drew from them the broad principles.

In order to discover the framework I examined all fighting from the elemental—man—upwards to the main campaigns of history. As I found that the principles were similar in each case I naturally used the simplest and most readily grasped source for explanatory purposes in the brief time available.

In the case of the " expanding torrent " I actually thought out the method first, and then the parable by which to make it live in the mind. The rising tide would scarcely be an apt metaphor for advocating speed of advance and penetration! The rotary brush suffers from the defect of being artificially controlled. Viewed broadly, there is a distinct analogy between a bank and a force which has taken up a position of resistance.

I admit that there is a certain danger in similes or parables, but I think that in most cases their illustrative and teaching value more than counterbalances such possible defects. The greatest of all Teachers used them continually. It might even be suggested that Colonel Bond's literary style might be lightened by them. It is to be remembered that the ordinary British officer or N.C.O. has not the hypercritical mind which examines such parables meticulously. Similes might possibly be used with advantage to lighten their paths through the morasses or sterile deserts of the ordinary textbook.

13.—Colonel Bond here finds fault with my use of terms. It would have been as well if he had verified his own data, before criticizing my failure in this respect. He assumes that his own view of what constitutes " science " is compulsory on all.

Colonel Bond restricts the definition of " science " to a very narrow use. I did not claim to evolve an *exact* science. I prefer to follow the definition in the *New English Dictionary* :—" A department of practical work which depends on the knowledge and conscious application of principles; an art, on the other hand, being understood to require merely knowledge of traditional rules and skill acquired by habit." Or again, in Webster's *Dictionary* :—

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"Systematized knowledge," "Knowledge classified and made available in work, or the search for truth."

Thomas Huxley's definition is perhaps even better, that science is "organized common-sense . . . the rarest of all the senses." (!)

Colonel Bond here repeats his assumption that my theories are based on conditions which I did *not* found them upon.

15.—Colonel Bond raises so many questions in this paragraph that I am restricted to comparatively brief replies if I am to deal with each one.

General and Question 1.—Firstly, let me say that I do not expect the "Expanding Torrent" method to be infallible. The commander who awaits a perfect method will never act. It is not the leader who makes no mistakes who wins, but the one who makes fewest. I agree, further, that this method requires a high standard of training. But that it is feasible I do believe, and apparently others more experienced than myself concur. To give one example, it is taught at the Small Arms School at Hythe, the staff of which represent at least as great and as wide experience of war as could be found in any similar number of individual officers in any army. To give another—it has been introduced by General King to the U.S. General Service Schools.

I repeat again that I am fully aware of its imperfections and possible defects, but can any better alternatives be put forward? Are we to revert to the method of massed waves and direct reinforcements, or again to the trench-warfare system of extreme limitation of objectives—down to the section or platoon? The one is surely too costly to be ever again employed against modern small arms fire, the other is too slow for open warfare, and entails severe risk of confusion owing to repeated direct passing through of one unit by another.

Question 2.—Surely the last war has disposed of the fallacy that troops cannot manœuvre under fire. (It is unlikely also that in the near future we shall see a fire zone so deep or so thoroughly beaten.)

The presumable origin of the idea that this procedure was impossible lay in the well-known psychological fact that troops were magnetically drawn towards a visible enemy who was firing directly at them. This attraction has been proved from Frederick's battles onwards. But I suggest that, so long as the firer is invisible and there is no clear evidence that you are being directly aimed at by a particular post near at hand, this magnetic attraction does not exist. Thus I would postulate that, whilst manœuvre to a flank is impossible for any forward sub-unit engaged with a definite defence post, it *is* possible normally for the supporting units, who do not feel the spell of direct fire contact.

Question 3.—In this and other questions Colonel Bond, despite his opening remarks on frontier conditions, appears to reveal his

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possession of what may be described as a mind saturated in Western Front trench warfare—at second hand.

Let me refer him to his own quotation of Mr. Winston Churchill as my authority for retorting that I do not visualize an overwhelming artillery or creeping barrages in the near future. How curiously inconsistent he is in his criticisms!

Question 4.—The emphasis which is now laid on the constant use of compass bearings should help to meet this danger.

Question 5.—I do not imagine that in practice the arrowhead will be meticulously maintained. In movement it is often likely to approximate to file, and, when halted, to line. But for training it has the advantage that, whilst ensuring control, it teaches men to keep alive to their direction instead of, as in file, lapsing into a somnolent gaze at their predecessor s back.

Question 6.—The supply of ammunition (*not* bombs) is undoubtedly one of the biggest problems due to the introduction of the light automatic. I confess that I can see no effective solution save the supply tank, as suggested in my lecture on page 180, *R.E. Journal*, April, 1921, and in *Infantry Training*, Vol. II. (*War*), 1921, Sect. 60, 11. I would, however, call his attention to page 218, *R.E.J.*, May, 1921, in which I point out that one of the advantages of the " Expanding Torrent " method is that the units who lead the advance will automatically be those who have expended least ammunition or have been able to refill.

Question 7.—I must again refer Colonel Bond to my lecture, pages 217 and 218, *R.E.J.*, May, 1921, in which it is clearly stated that the decision as to the replacement of a forward platoon rests with the company commander. The " Expanding Torrent " method gives the immediately superior commander a much higher degree of control over his sub-units than previous methods. Further, looking back may have disadvantages, but it does at least ensure that the immediately superior commander can apply a brake to the advance of his forward sub-units.

16.—Colonel Bond asserts that this method can only succeed if we assume certain conditions, which I will recapitulate with my own comments :—

(*a*) *An enemy in separated and distinct posts.*—I suggest that the machine-gun and light automatic, and the grouping tendency, which has always been inherent in human nature, will cause these to be normal in any system of defence in depth—to counter which is the purpose of the " E.T." method.

(*b*) *A perfect knowledge of the positions of these posts.*—The " E.T." method is based on the fact that the exact points at which resistance will occur cannot be anticipated, and that a method is needed which will allow of adjustment to the

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degree of resistance at any particular spot. The platoon leap-frogging method, which Colonel Bond appears to favour, *does*, on the other hand, demand exact knowledge of the enemy defence posts.

(*c*) *Leaders who can be relied on to take correct tactical decisions.*—I agree that modern war has no use for stupid leaders. We must be ruthless in selection and persevering in training. See *F.S.R.*, Vol. II, Section 1, 2.

(*d*) *No time-table to adhere to, as with a barrage.*—My training theories are not based on a recurrence of trench-warfare. I again refer Colonel Bond to his own quotation of Mr. Winston Churchill.

(*e*) *Troops under complete control, and ready and willing to attack a series of objectives.*—See my answer to question 7, for the first part. For the second part, I would point out that the men will start the attack with but one objective impressed on them—to gain the battalion objective.

(*f*) *A passive enemy.*—Surely the experience of the war proved that the danger of temporarily exposed flanks in the case of platoons and companies was overrated. On the Somme, in July, 1916, I can even remember a whole brigade having both flanks in the air for forty-eight hours, during and after an attack, without accident. Moreover, the "E.T." system has the specific advantage of covering the flanks of a forward unit which is able to progress, with the least possible delay. Moreover, by means of it, an enemy counter-attack against an exposed flank will itself be taken in flank.

Finally, when Colonel Bond implies that I put forward the "Expanding Torrent" as a universal system, he is guilty of still another deliberate distortion of my meaning. In my introductory remarks I specifically pointed out the special conditions which it was designed to meet.

17.—(i) The method of disposing manœuvre or supporting units on a flank is now accepted both in the French and British infantry regulations, which would prove that "officers of experience" consider it to be sound.

(ii) The natural tendency for any attacker is to take the line of least resistance. To go dead in the face of this tendency is to violate human nature.

(iii) Posts will be sited to support each other mutually with fire (See *I.T.* and lecture). "Each post will form a self-contained centre of resistance, capable of all-round fire."

(iv) Colonel Bond's next criticism is hardly creditable to his common sense. Is he really incapable of distinguishing between the parts and the whole, or of realizing that the

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fixing of their immediate attackers by the minor infantry units is different from the fixing or stabilizing of the whole battle referred to in *F.S.R.* ?

In the case of the whole force, with which *F.S.R.* deals, the portion of it which is assigned to hold the position corresponds to the *forward body* (of my lecture and *Infantry Training*), whilst the general reserve for the counter-stroke corresponds to the manœuvre (or supporting) body. The object of the first body in either case is to fix the enemy (*i.e.*, absorb his attention, vigour, and reserves) ready for the counter-blow by the second body. Incidentally, the outpost zone defined in *F.S.R.* does not correspond with the forward of the two portions of a force. It is an area of ground, not a body of troops, and is garrisoned by only the advanced fraction of that portion of the force which is holding the defensive position.

(v) On the subject of the limitation of platoon and company objectives, Colonel Bond refers to a distinguished author whose book is based on trench-warfare conditions of the period during which it was written.

In the first place I would refer him to *Infantry Training*, 1921, where the doctrine is accepted that the platoons and companies of a battalion should have as their mission to gain the battalion objective. In the second place I would suggest to him that, save in trench-warfare and other exceptional conditions, a battalion will be required to make an advance of considerably more than 800 yards. In what normal theatre of war in which the British Army has been, or is likely to be, engaged has the commander had so many troops or such unlimited time to waste that he could afford to ask only such a short advance? But if a longer advance is required, and platoons are to be assigned to definite objectives in depth and then to sit down while other platoons leap-frog them, the battalion will be strung out over a distance too great for the retention of control. Again, how rarely does our Army operate in terrain so well known that separate objectives can be allotted beforehand to each platoon! If no objective of any sort is assigned beforehand, what confusion and loss of direction will ensure!

18.—If I quote the whole paragraph, No. 111, from the French regulations, perhaps Colonel Bond will be satisfied that I am justified. "In the course of the combat the reliefs are made in the form of '*dépassements*' or '*passages de ligne*' which can generally only take place at the end of a halt of some duration. In principle, every unit engaged ought to pursue its effort to the full limit of its offensive capacity. At the same time, it is for the commander to judge whether it is not preferable and whether it is possible to withdraw from the leading echelon those elements which, owing to fatigue, have no longer sufficient efficiency. These elements are capable,

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after several hours or days in reserve, of furnishing a fresh effort, whereas if kept in the leading echelon they would obtain little result and would even diminish the *élan* of fresh reinforcements. This operation is carried out above all, between battalions of the first and second echelon, and sometimes between companies of the first echelon. On the contrary, inside the company, the groups, in principle, are not relieved."

19.—The answer to this paragraph is contained in my opening remarks on the question of experience. Nevertheless, it cannot be doubted that individual experiences have a certain value, which increases in proportion to their number. But in the first place it is necessary to find an Editor who will give the space to a quantity of individual experiences, whilst, secondly, the British officer is diffident about giving the undue prominence of print in a Service journal to his own necessarily limited personal experiences.

20. Colonel Bond's criticism, taken as a whole, appears to be, directed, above all, to the feasibility and practicability of a framework, and its value. May I refer him to an article of mine in the *R.U.S.I. Journal* for November, 1921, which discussed at some length the arguments in favour of a framework. Colonel Bond asks for personal experiences. The strongest impression which I derived from my own small experience of active service was of the confused and at the same time inelastic method of thought common to almost every officer, old or new, when confronted with the solution of any tactical problem. The confusion resulted from the unclassified mass of precepts and reservations which they had imbibed from the textbooks and manuals. The lack of elasticity arose from the fact that each individual's tactical thought was cramped and deformed in its infancy by the experiences of that individual, which even in the case of the most experienced were narrow and infinitesimal compared with the universal experience of war as a whole.

Laying no claim to Colonel Bond's omnipotence, or to any immunity from the defects common to human nature, I freely admit that I floundered in common with the rest. A minority, however, who are sufficiently keen, will always fight their way out of the morass to a foothold on the bedrock principles. It would appear from the very names—Major Pott and Colonel Blunderbore —which Colonel Bond gives to his typical leaders, that he does not regard the ordinary senior officer to be of the type who would be capable of the study, the reflection, the patience and the analytical power needed for evolving for themselves an effective tactical doctrine of classified principles. After all, military history bears witness to the rarity of generals even of the past who have succeeded in this respect.

But the subaltern and serjeant, who are usually the company and platoon commander respectively in war, are even less likely to

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have the time or ability to work out a tactical doctrine or framework for themselves. To give the ordinary manual, with its mass of unclassified precepts and considerations, into their hands is simply to give them mental indigestion. Nor are they likely to gain a clear grasp of the principles from the highly imaginary conditions of a tactical exercise in peace-time or from the narrow range of their experiences in war. In any case, to evolve a scientific method of tactical thought requires so prolonged an apprenticeship that by the time they have acquired it they will no longer be company and platoon commanders.

It is evident, from Colonel Bond's article on the "Principles of War" in the *R.E. Journal* for March, that he does realize the need for supplying the ordinary officer with a ready-made foundation of principles on which to develop his tactical knowledge and experience, and in order to obtain a common method of appreciating a tactical problem.

I fear, however, that so diffuse and unclassified a list as he gives is of no practical use to the ordinary officer groping for light. How can the latter possibly, when confronted with a problem, weigh up seven so-called principles to each of which is appended a number of means and considerations, none of which are classified according to proportionate values nor arranged in any sort of relation.

Colonel Bond's sublime disregard of the beam in his own eye when searching for the mote in mine, is shown by the fact that he states the seven "basic principles of war," without the slightest attempt to show from what source or by what means he deduced these principles upon which we are invited to build up our tactical doctrine. Perhaps he considers that "a confident and oracular tone" will take the place of any deductive reasoning.

There is certainly one of his universal principles, "that victory can only be gained by defeating in battle the armed forces of the enemy," which was shown by the last war to be distinctly unstable. The conquest of the enemy nation's will to resist is the fundamental principle and if, with new developments, this can be effected without the former result, the armed forces can and will be neglected as the main objective.

The ordinary officer seeking a foundation to clear-cut principles which he can apply to any problem in order to obtain a sound solution, requires something more concrete than the vaguely phrased and uncorrelated platitudes.

Colonel Bond's criticisms were so violent in tone that he could scarcely have complained if I had counter-attacked in similar style, Let me, however, suggest, in conclusion, that it is always a pity when any searcher after truth quits the path of dispassionate and logical constructive argument in order to abuse a fellow searcher. "Thinking in a passion" is the last means by which we can draw

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nearer to truth, and is only one degree less harmful than mental inertia. When the mass of people who lie dozing are awakened merely to see those who are awake hurling verbal brickbats at each other, they turn disgusted on the other side and fall asleep again, deaf to the pressing problems of national security. So, in another sphere of the search after truth, did the Arian and Roman creeds fight each other, until both were engulfed by the barbarians, and the Dark Ages followed. So, again, did the Roman Catholics persecute the Protestants, and the Protestants the Catholics, while Europe fell prey to unrestrained anarchy and tyranny. So in our own England, the High Church Party of James I, Charles I, and Laud persecuted the Puritans, and with the swing of the pendulum the Puritans oppressed the former. So now the world has fallen into the gross slumber of materialism because the rival creeds cannot refrain from warring with each other.

How often have the searchers after truth found their greatest opposition, not from the somnolent multitude whom they set out to awaken, but from the previous body of searchers who, having climbed a few steps up the difficult path, devote their future efforts, not to climbing further but to pushing down any fresh climbers. The cases of Roger Bacon, Galileo, Stephenson, Darwin, are but a few outstanding examples of the violence with which the supporters of the established theory of the moment oppose any further researches on unorthodox lines. The Medical Authorities' attitude to Sir Herbert Barker is an even more recent example of this perverted instinct on the part of the professed seekers after truth to suppress fresh truths, and of their refusal to adapt themselves to changing realities. Surely in the military sphere which so vitally concerns the security and continuance of our country, we should avoid this pharasaical tendency. The theory of uncontrolled liberty of tactical dispositions which Colonel Bond supports had, in its turn, an uphill fight against the formalism of last century. Is it not possible that the pendulum has now swung too far towards individualism, and that a mean course might be more effective in order to prevent confusion in the minds and actions of the junior leaders, resulting in possible chaos and defeat? I suggest that such a mean is represented by a framework of principles, together with a superstructure of *normal* methods based on these principles which are to be understood as flexible and necessarily adaptable to situations which are unusual.

Again, it is possible that both Colonel Bond and I have gone too far in our opposing directions. But in any case it is surely to the advantage of our common goal—military truth—that we should have a spirit of mutual toleration.

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REVIEWS.

GERMAN REPAIR OF RAILWAYS IN FRANCE AND BELGIUM.

"Das deutsche Militär-Eisenbahnwesen im Weltkrieg 1914–1918. Die Wiederherstellung der Eisenbahnen auf dem Westlichen Kriegsschauplatz." VON W. KRETSCHMANN. (Berlin: Mittler, 180 Marks.)

THIS account of the repair of railways in the Western theatre of war—the first instalment of the history of the German railway service during the war—appears to be an official one; for the author describes himself as *Archivrat* and member of the *Reichsarchiv*, an institution which has taken the place and continues the work of the banned Historical Section of the General Staff. During the war he was Major in the General Staff of the Chief of the Field Railway Service.

His text is full of matters of interest; there is, besides, an excellent map showing the dates on which the sections of the railway system were opened for traffic and the new lines built; and there are 59 photographs, besides numerous diagrams, showing mostly the demolition and repair of railway bridges.

The peace establishment of the German military railway service consisted of two brigades (Berlin and Hanau) containing 28 companies (Railway Regiments Nos. 1, 2 and 3 with eight each, and No. 4 with four), and a Traffic Section (three companies), all under the Prussian Inspector of Railway Troops; and an Independent Bavarian battalion of three companies. Each brigade had charge of a depôt of railway stores.

On mobilization there were formed 90 companies:

30 Railway Construction Companies,
26 Reserve Railway Construction Companies,
7 Landwehr Railway Construction Companies,
11 Fortress Railway Construction Companies,
4 Railway Labour Battalions (later called Railway Auxiliary Battalions) each of 4 companies.

The strength of the active and reserve companies was, excluding medical officers and paymaster, 9 officers and 275 men; Landwehr, 5 and 229; Fortress, 5 and 330; Labour Battalion, 23 and 1148. Total, in round figures, 26,000 men.

The Staffs consisted of:—Brigade, 3 officers, 2 clerks; Regiment, 2 officers, 1 clerk; and 8 spare officers. These numbers proved wholly insufficient.

The railway troops, too, were found inadequate in numbers. Very early in the war the number of Construction Companies had to be increased, and a number of special units formed, *e.g.*, for removing débris of bridges from canals and rivers, for working labour-saving

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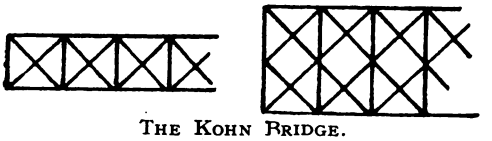
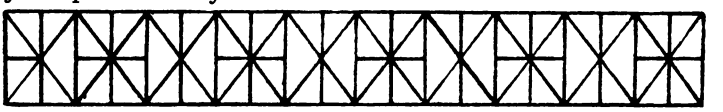
machinery, for repairing tunnels, and restoring signalling systems, water supply, etc. The numbers employed are not given. Eventually, recourse was had to private firms and contractors for rebuilding important bridges.

The railway stores of the peace establishment proved suitable and sufficient, except as regards oxygen-cutting plant and cranes for very heavy weights. The stores of each company were carried in ten railway trucks, but the construction trains gradually increased in length and proved a nuisance, at any rate in the East where sidings were few. Each company had five four-horse wagons, so that it could push on in front of railhead to do repairs; but they could not carry much, whereas Austrian companies had sufficient horse-transport to carry all their stores. The author does not mention motor lorries.

The German Army possessed two types of standard railway bridges: Sch (Schultz) and L (Lübbecke); the former for a span of 30–36 metres and the latter for 20–60 metres. They were not popular, and the Austrian patterns *Kohn* and *Roth-Waagner*, with spans up to 100 metres, proved superior. Both of these constructions were parallel, square-framed girders, whose members were not connected at their junctions by hinged bolts, but secured by riveted web-plates and joined by bolts. The erection of the bridge was, if possible, carried out on scaffolding, but it could also be built out without it. As the elements of the bridge were formed by very few parts, the erection was extraordinarily simple and easy to superintend. The principle observed in our bridges, that no part should be heavier than a man could handle, was departed from in the Austrian patterns with great advantage.



THE KOHN BRIDGE.



THE ROTH-WAAGNER BRIDGE.

Germany took into the field a 60-cm. narrow gauge railway. But the author says:—

"The war has shown that only standard gauge railways are in a position to deal with the tremendous transport demands of modern armies, and the narrow gauge is out of the question as a substitute for damaged railways or lack of standard gauge railways in mobile warfare. The construction of narrow gauge lines always requires time and labour out of proportion to their value, which could be employed with greater profit in the rapid repair of the standard gauge, and this applied even in the Eastern theatre of war, which was poor in railways. The carrying power of the light railways, especially at first, is trifling. . . . The experiences of the war have repeatedly confirmed and proved these principles:—That the construction of narrow gauge railways is only justified for supplying the front positions in trench warfare and for economic purposes behind the front."

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The repair of signal, telegraph and telephone systems and water supply gave far more trouble than repair of the lines.

The railway organization, with a Chief of the Field Railways at G.H.Q., who was responsible both for constructions and traffic, proved satisfactory.

Fifteen advanced sections, each of 2 officers, 8 N.C.O.'s and 81 men, were formed on mobilization to assist detraining. Parties were also formed for reconnaissance of damaged railways; no photographic apparatus was included in their equipment, and this was much wanted.

The arrangements for the protection of railways were insufficient; special measures had to be taken to prevent depredations by the German troops themselves, who often smashed signals, telephones, etc., because they were in enemy country.

It is stated that the damage done to their railways by the Belgians did not take long to restore, except the destruction of the Trois Ponts tunnel and the bridge over the Ourthe at Melreux; but we find that the line, "so important for shifting troops from the left to the right wing," Thionville–Libramont–Namur, was not fit for traffic until the 8th September, and even then the Meuse bridge at Namur had not been restored. In France so many bridges and tunnels had been thoroughly demolished that their rapid repair was out of the question. Demolition of tunnels at both ends and in the centre caused great delay. During the battle of the Marne only four lines of rail were available:

1. Aix-la-Chapelle–Brussels–Cambrai, whence there were three branches to Roye, Chauny and St. Quentin.
2. Liége–Namur–Charleroi–Berzée, whence there was a single line to Anor, just inside French territory, and north of Hirson.
3. A single line from Malmedy to Libramont, and thence to Marbehan and just over the French frontier, short of Montmedy.
4. Thionville–Longuyon, again only just into France.

The author states that the railway connection with Kluck's Army was "favourable beyond expectation;" and this remark is justified, for that commander's furthest south was only fifty miles from his railheads, and the centre of his Ourcq front was less than thirty; and during the battle of the Marne the Chauny line was extended to Noyon on the 8th, and Compiègne on the 9th, only just behind the front. Kluck's excuses that his Army had outrun the railway service seem therefore to have no basis.

For the repair of the most important bridges and viaducts, civilian contractors were called in as early as the 1st September, 1914. Steel construction was used. A 130-metre span bridge at Namur was built in 27 days between the 4th and 30th September, 1914; others in France took from 37 to 43 days. The firms received 10 to 15 per cent. profit on the cost.

In 1915–1916 three strategic double tracks were built, mostly by contract with prisoner labour, in order to improve the connection between the home railways and Belgium.

These were:—

1. Aix-la-Chapelle–Visé–Tongern, along the Dutch frontier (44.5 km.).

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2. Born to Vielsalm (22 km.) and the single line doubled from here to Rivage (south of Liége).
3. St. Vith–Gouvy (20·9 km.) and the single line doubled from here to Libramont (57 km.).

There are full details of the work done on reconstruction of bridges and the three new lines.

J.E.E.

DESIGN OF PIPE-LINES, ETC., AND ACCURATE MEASUREMENT OF WATER.

In *Hydraulic Flow Reviewed* (Spon: Price 15/- nett), Mr. A. A. Barnes gives the results of very careful investigations into the flow of water. He has devised a series of formulæ, variations of one general formula, by means of which pipe-lines can be designed with greater accuracy, and, in the long run, with greater ease, than by means of the formulæ now in general use; and the following notes on his book may, I think, be of interest and value to R.E. officers engaged on this kind of work.

I.—Flow of Water in Pipes, Channels, Canals and Rivers.

In considering the above, the following symbols are used:—

v = mean velocity of flow in feet per second
Q = quantity flowing in cubic feet per second
A = cross-sectional area of pipe or channel in square feet
$w.p.$ = wetted perimeter in feet
m = mean hydraulic depth = $A/w.p.$
i = hydraulic slope = (for pipes) $\frac{\text{net fall}}{\text{length of centre-line of pipe}}$
= (for channels) $\sin\theta$, not $\tan\theta$.

The best-known of the formulæ now in general use is probably Chezy's, which dates from 1775 and is

$$v = c\sqrt{mi}.$$

The difficulty in applying this formula lies in the fact that the coefficient "c" is not even a constant for any one class of pipe or conduit, but varies also with the size of pipe and with the gradient; varies, that is to say, with m and i. It was therefore concluded that the square-root powers were not the correct indices of m and i and that the true formula was in the nature of

$$v = K\, m^{\alpha}\, i^{\beta}.$$

Mr. Barnes appears to have shown conclusively that for any type of pipe or channel values can be found for K, α and β, which will give the value of "v" very closely, whatever the size or slope may be, and he has also shown how these values may be obtained.

In his book he gives details of over 800 observations and experiments which have been made by various reliable authorities in the course of the past 100 years or so and which cover most types of water-course from small glass pipes up to the Mississippi River. These are summarized in Table I and the formulæ deduced from them given. The closeness between the measured flow and that given by his formulæ is very striking.

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The following is one of the examples which he gives to illustrate the use of the formulæ:—

A conduit is to be constructed of concrete with a flat invert and vertical side-walls. It is required to supply permanently a city of one and a half million inhabitants with 30 gallons per head per day. The available fall is 2 ft. per mile, and an easement has been acquired sufficient to accommodate a channel of 6 ft. internal width. Find the necessary height of the side walls.

Quantity = 1,500,000 × 30 = 45,000,000 gallons per day.

Add 5% for deterioration of channel, making 47,250,000 gallons per day.

Hence Q = 87·64 cub. ft. per second.

$i = \frac{2}{5280} = \cdot 0003788$; $\log i = \bar{4}\cdot 57840$

The formula for new concrete is:—

$$v = 95\cdot 1\, m^{\cdot 567}\, i^{\cdot 471}.$$

Working by trial and error, try a depth of 5 ft.

Then $m = \frac{6 \times 5}{6+5+5} = 1\cdot 875$; $\log m = \cdot 27300$.

From formula, $\log v = \log 95\cdot 1 + (\cdot 567 \log 1\cdot 875) + (\cdot 471 \log i)$.

$$\therefore \quad \log v = 1\cdot 97818 + (\cdot 567 \times \cdot 27300) + (\cdot 471 \times 4.57840)$$
$$= 1\cdot 97818 + \cdot 15479 - 1\cdot 61157$$
$$= \cdot 52140$$

Hence $v = 3\cdot 322$ ft. per second

$Q = Av = bdv = 6 \times 5 \times 3\cdot 322 = 99\cdot 66$ cub. ft. per second

Hence 5 ft. is too deep, for the required Q is only 87·64 cub. ft. per second.

Now assume for the moment that "v" remains constant,

then $$A = \frac{Q}{v} = \frac{87\cdot 64}{3\cdot 322} = 26\cdot 4 \text{ sq. ft.}$$

$$\therefore \quad \text{approx. depth} = \frac{A}{b} = \frac{26\cdot 4}{6} = 4\cdot 40 \text{ ft.}$$

Since the velocity, however, will be slightly less for the shallower depth, we should take a depth of 4·50 ft.

This, when tested, is found to be correct. Hence the side walls should be 4 ft. 6 in. high.

For pipes the calculations are simpler, since, as $m = \frac{D}{4}$, no trial and error working is needed.

It may be objected that it is unnecessary to work to such extreme accuracy as is demanded by the use of a formula involving indices with three places of decimals when an allowance of as much as 55% may be made for deterioration. The indices, however, are those read off from the graphical determination to be described later, and there seems nothing to be gained by altering them. As shown above, too, the formulæ are very simple to use, even though they may at first sight

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look alarming. The only thing, indeed, which can be said against them on this score is that they require the use of logarithms instead of merely a slide-rule, not a very big objection in designing an expensive piece of work. Surely, too, it is better to know what discharge a new pipe-line will give to one or two per cent. and to make a reasonable allowance for deterioration than it is to use a formula, such as Chezy's, which may easily give an initial error of 30 or 40 per cent.

The formula for earth channels and rivers might have, it is pointed out, a particular interest for exploration parties, who might get valuable information as to the discharge of rivers without having the time or apparatus for a long and costly series of current-meter observations. If a fairly regular reach of a river can be found, *i.e.*, a length in which the fall of the water is approximately parallel to the bed and the width and depth are more or less constant, it should not be difficult to take a few soundings for a cross-section and approximately to measure the slope of the water, possibly by aneroid if the reach is long enough, so getting the values of m and i. The discharge should then be given with a very small percentage error by the formula :—

$$v = 58{\cdot}4\ m^{\cdot 694}\ i^{\cdot 496},$$

which may be modified without serious error, if preferred, to :—

$$v = 58{\cdot}4\ m^{\cdot 70}\ i^{\cdot 50}.$$

Graphical Determination of Formula.

Mr. Barnes gives very fully the steps by which he arrived at his method for determining the values of K, α and β ; and the necessary construction may be of interest, even without a full explanation. Three measurements only are required, provided that these are made with sufficient accuracy. All that is required is to have two short experimental channels constructed of exactly similar materials, with their inverts of different known slopes.

In the first channel two observations are made at velocities of, say, 3 ft. and 7 ft. per second, and the respective values of m measured.

In the second channel one observation is made at any velocity and m measured.

Suppose that the three sets of readings have been taken in, say, a brick channel and that the values obtained are as follows :—

Observation	i	log i	m	log m	v	log v	Point on diagram
1	·005025	$\bar{3}$·7011	·284	$\bar{1}$·4533	3·665	·5641	A
2	·005025	$\bar{3}$·7011	·779	$\bar{1}$·8915	6·716	·8271	B
3	·0000668	$\bar{5}$·8248	2·284	0·3587	1·716	·2346	C

On the largest practicable scale, with values of log m on the x-axis and of log v on the y-axis, plot the points A, B and C. (See *Fig.* 1).

Join A B and produce as required.

Through C draw C E parallel to A B.

Mark against A B and C E their respective log i values.

Draw any line normal to A B—say O F. This is the log i scale.

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The values of log i on it are known at the two points of intersection with A B and C E.

Complete the scale. Let R be the point in O F where log $i=0$.

Through R draw P R S parallel to A B cutting the x- and y-axes in P and S respectively.

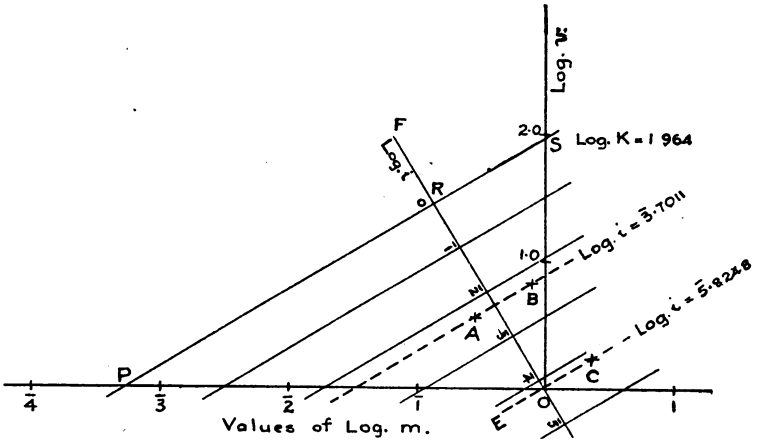

FIG. 1.

Now at S, log m=log i=0, $\therefore$ $m=i=1$

$\therefore$ from general formula $v=K m^{\alpha} i^{\beta}$ $\therefore$ $v=K$

$\therefore$ log K=log v=length O S=1·964. $\underline{K=92{\cdot}1}$

And α=index of m=slope of P S=$\frac{O S}{O P}=\frac{1{\cdot}964}{3{\cdot}263}=\underline{{\cdot}602}$.

Now log v=log K+α log m+β log i.

Substitute the values found for "K" and "α" and the values given by observation (1) for v, m and i.

Hence it is found that $\underline{\beta={\cdot}466}$.

For brick channels therefore the flow formula is:—

$$v=92{\cdot}1\ m^{{\cdot}602}\ i^{{\cdot}466}.$$

If much work has to be done with one class of pipe or channel the diagram can easily be altered to give direct readings by looking up a number of anti-logarithms.

N.B.—The critical velocity is one foot per second, and the formulæ will not be accurate for lower values of v.

II.—ACCURATE MEASUREMENT OF FLOW.

In order to construct a formula in the manner just described it is necessary to be able to make very accurate measurements of flow in the initial experiments, and the second part of the book deals with methods of doing this by means of notches, weirs with and without end contractions and circular orifices.

The general formula is now:—

$$v=K\ m^{\alpha}\ H^{\beta}$$

which is of the same nature as the other, since slope is a function of H.

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TABLE I.

List of Formulæ for Flow of Water in Pipes, Channels, Canals, and Rivers.

Materials of Construction	Formula for MEAN VELOCITY in feet per second	Formula for FRICTION HEAD in feet.	Formula for Q in cu. ft. per sec. (pipes) h.m.d. in ft. (channels).	Number of experiments by various authorities.	Range of Experiments.	Comparison of Formula with observations.	For purposes of DESIGN to allow for deterioration.
PIPES :—							
New asphalted cast-iron pipes	$v = 174{\cdot}1\ m^{\cdot 769}\ i^{\cdot 529}$	$h = {\cdot}0000581 \frac{lv^{1\cdot 891}}{m^{1\cdot 454}}$ $= {\cdot}000436 \frac{lv^{1\cdot 891}}{d^{1\cdot 454}}$	$Q = 47{\cdot}087\ d^{2\cdot 769}\ i^{\cdot 529}$	79	$d = 3$ in. to $61\frac{1}{8}$ in. $i = {\cdot}0000689$ to ${\cdot}0681$ $v = 1{\cdot}00$ to $8{\cdot}70$	60 agree to 2%	Add 45% to Q
New uncoated cast-iron pipes	$v = 136{\cdot}6\ m^{\cdot 600}\ i^{\cdot 512}$	$h = {\cdot}0000675 \frac{lv^{1\cdot 953}}{m^{1\cdot 172}}$ $= {\cdot}000343 \frac{lv^{1\cdot 953}}{d^{1\cdot 172}}$	$Q = 46{\cdot}699\ d^{2\cdot 600}\ i^{\cdot 512}$	37	$d = 3\frac{1}{4}$ in. to $19\frac{11}{16}$ in. $i = {\cdot}00045$ to ${\cdot}17072$ $v = 1{\cdot}175$ to $16{\cdot}168$	25 agree to 2%	Add 55% to Q
New asphalted, screw-jointed riveted wrought iron pipes	$v = 190{\cdot}2\ m^{\cdot 608}\ i^{\cdot 557}$	$h = {\cdot}0000809 \frac{lv^{1\cdot 795}}{m^{1\cdot 092}}$ $= {\cdot}000368 \frac{lv^{1\cdot 795}}{d^{1\cdot 092}}$	$Q = 64{\cdot}305\ d^{2\cdot 608}\ i^{\cdot 557}$	14	$d = 3\frac{1}{4}$ in. to $11\frac{1}{4}$ in. $i = {\cdot}00070$ to ${\cdot}15605$ $v = 1{\cdot}171$ to $19{\cdot}720$	11 agree to 2%	Add 33% to Q
New asphalted single-riveted wrought iron and steel pipes	$v = 171{\cdot}4\ m^{\cdot 723}\ i^{\cdot 527}$	$h = {\cdot}0000576 \frac{lv^{1\cdot 898}}{m^{1\cdot 372}}$ $= {\cdot}000386 \frac{lv^{1\cdot 898}}{d^{1\cdot 372}}$	$Q = 49{\cdot}409\ d^{2\cdot 723}\ i^{\cdot 527}$	16	$d = 10\frac{7}{8}$ in. to $25\frac{7}{8}$ in. $i = {\cdot}00502$ to ${\cdot}03318$ $v = 4{\cdot}383$ to $12{\cdot}605$	14 agree to 2%	Add 33% to Q
New asphalted double-riveted wrought iron and steel pipes (taper cylinder joints).	$v = 129{\cdot}9\ m^{\cdot 440}\ i^{\cdot 520}$	$h = {\cdot}0000862 \frac{lv^{1\cdot 923}}{m^{\cdot 846}}$ $= {\cdot}000279 \frac{lv^{1\cdot 923}}{d^{\cdot 846}}$	$Q = 55{\cdot}436\ d^{2\cdot 440}\ i^{\cdot 520}$	65	$d = 17$ in. to $103\frac{3}{8}$ in. $i = {\cdot}0000676$ to ${\cdot}06672$ $v = 1{\cdot}06$ to $20{\cdot}143$	31 agree to 2%	Add 33% to Q
Clean lead pipes	$v = 232{\cdot}8\ m^{\cdot 679}\ i^{\cdot 591}$	$h = {\cdot}0000988 \frac{lv^{1\cdot 692}}{m^{1\cdot 149}}$ $= {\cdot}000486 \frac{lv^{1\cdot 692}}{d^{1\cdot 149}}$	$Q = 71{\cdot}330\ d^{2\cdot 679}\ i^{\cdot 591}$	24	$d = \frac{1}{4}$ in. to $1\frac{19}{32}$ in. $i = {\cdot}00778$ to $3{\cdot}873$ $v = 1{\cdot}089$ to $14{\cdot}290$	15 agree to 3%	Add 5% to Q
Clean glass pipes	$v = 143{\cdot}0\ m^{\cdot 562}\ i^{\cdot 556}$	$h = {\cdot}0001329 \frac{lv^{1\cdot 799}}{m^{1\cdot 011}}$ $= {\cdot}000539 \frac{lv^{1\cdot 799}}{d^{1\cdot 011}}$	$Q = 51{\cdot}532\ d^{2\cdot 562}\ i^{\cdot 556}$	8	$d = \frac{3}{32}$ in. to 2 in. $i = {\cdot}00771$ to ${\cdot}12918$ $v = 1{\cdot}591$ to $6{\cdot}916$	All agree to $1\frac{3}{4}$%	Add 5% to Q
TROUGHS OR PIPES: Clean planed wood							

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The formulæ are detailed in Table II and should all give results with errors of well under 1 per cent.

The following are the chief points to notice in using them :—

(A) *Triangular Notches* (suitable for flows from 10 gallons per minute up to 1,000 gallons per minute).

H =head from dead-water to apex of notch.

A =area of the triangle of this depth H.

w.p.=perimeter which would be wetted if the water ran through the notch with depth H (not perimeter actually wetted).

m =A/*w.p.*

v =mean velocity through area A.

Q =discharge through notch.

All units in feet and/or seconds.

The formulæ are for a thin-surface notch of 1/16th inch thickness.

The head should be measured with a hook gauge 6 ft. up-stream.

On the up-stream side the channel should be proportioned to give a mean velocity of not more than 0·50 ft. per second. If this is impossible add $\frac{v^2}{100}$ to the observed head to allow for the velocity of approach (u).

Up-stream, the width of the channel should be at least 4 ft. up to a 9-in. head and at least 6 ft. for higher heads. There must be no projecting surfaces whatever, since these would interfere with the "stream-line" flow of the water to the notch.

The depth from the bottom of the notch to the bottom of the channel should be at least 6 in. on the down-stream side and on the up-stream side should be at least 12 in. for heads up to 9 in., and at least 18 in. for higher heads.

The down-stream water level may rise to the apex of the notch, but no higher.

These rules ensure proper contraction and will also probably keep the velocity of approach within the requisite limit.

The critical head is 2 in., and the formula will not hold except for higher heads. A 2-in. head, however, is only equivalent to 10 gallons per minute with a 90° apex.

The velocity formula is also true for smaller angles than a right angle.

(B) *Rectangular Weirs with Full End and Bottom Contractions.*

This means that the weir should be so much narrower than the channel of approach, and its lip so much higher than the bed of the channel that every particle of water passing over it may assume that direction which it would take up if passing out of a pool of infinite dimensions.

The weir should therefore comply with the following rules :—

(1) Neither of the sides of the channel should be nearer any point of the weir crest than twice the head, and the distance from the bottom of the channel to the weir-crest should be not less than three times the head, the minimum distance in every direction being 12 in.

(2) On the down-stream side neither the bed nor the sides should be nearer the weir than 6 in. The tail-water may be allowed to rise to within 3 in. of the weir-crest but not higher.

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These down-stream conditions are necessary to allow the water to expand freely sideways after leaving the weir, and to ensure there being a clear space under the falling water which will be in direct communication with the air and therefore at atmospheric pressure.

The weir-lip should be $\frac{1}{4}$ in. or less in thickness, with the upper lip sharply formed so that the water springs clear.

There is no " critical head " with weirs.

The weir may be divided into two or more bays. The distance between adjacent bays must then be at least four times the head, otherwise full end contraction will not be obtained.

(C) *Rectangular Weirs without End Contractions.*

This method, which is almost as accurate as the above, might on occasions be more convenient than a weir with end contractions, *e.g.*, for very large quantities of water indeed, or for a conduit with no special gauging-site.

The bottom contraction still exists and so the water should still spring quite clear of the weir-crest. The tail-water should, therefore, not rise higher than 3 in. below the crest and air-pipes must be passed through the side walls immediately below crest level so that the underside of the " nappe " may, as before, be at atmospheric pressure. This is important.

(D) *Circular Orifices.*

H=head in feet above centre of orifice.

The well from which the water flows should have a large area so that the velocity of approach may be negligible.

The contraction of the jet should be complete, the sides and bottom of the well being at least three diameters away from the edge of the orifice.

Low heads are to be avoided, especially with large quantities of water, as vortices may form.

The critical head is 18 in. for orifices of $\frac{3}{4}$ in. diameter and upwards ; 2 ft. for a $\frac{1}{2}$-in. orifice, and 4 ft. for a $\frac{1}{4}$-in. orifice.

The formula holds good up to 12-in. diameters at least, and at the other extreme will measure quantities of little more than 1 gallon per minute.

At the end of the book, several diagrams are given which eliminate the calculations demanded by the formulæ for most cases. They give direct-reading values for flow in cast-iron pipes, steel pipes, brick channels, earth channels and rivers and " slimy sewers " ; also for measurement of flow by circular orifices and both kinds of weirs.

The collection under one cover of all the standard experiments forms a very valuable feature of the work, and nothing could be fairer than the comparison of the actual observation with the result obtained by the use of the formula in each case.

I have to acknowledge Mr. Barnes' very great kindness in allowing me to reproduce Tables I and II, and to take so many *verbatim* extracts from his book. I am confident that the book itself would prove of very great interest to a large number of R.E. officers.

J. S. BAINES, *Capt., R.E.*

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OTHER PUBLICATIONS.

THE Editor has received *An Introduction to Forecasting Weather*, by P. Raymond Zealley, F.R.MET.SOC. (Cambridge: W. Heffer & Sons, Ltd.), price 1s, a short and clear explanation of the preparation of Synoptic Charts; and also, from Lieut.-Colonel R. H. Rowe, D.S.O., M.C., R.A., Surveyor-General, Gold Coast Survey, a folding map of Accra to the scale of 1/125,000, as a specimen of the work of the Gold Coast Survey, which is being carried out under the authority of Brig.-General Sir F. G. Guggisberg, K.C.M.G., D.S.O., Governor. The map is reproduced and printed by Messrs. W. and A. K. Johnston, Ltd., Edinburgh, and is notable for its clearness, while the amount of useful information which it gives about the Colony may be estimated from the fact that it is accompanied by a table of 89 conventional signs. Accra is one of nine sheets. Price per sheet, 5s. unmounted, 6s. mounted.

NOTICES OF MAGAZINES.

MILITAR WOCHENBLATT.

No. 4.—*July 22nd*, 1922.

THE RUSSIAN ARMY IN THE WORLD WAR.—A review by Gen. von Kuhl of the work entitled *Mémoires de Russie*, by Prof. Jules Legras, who was sent to Russia by the French Government in February, 1916, on a special mission (propaganda work). Attention is called to those parts of the volume in question which deal with the causes which led to the "cracking up" of the Russian Army; the chief of these causes were the incompetence of the higher leaders, the aloofness of staff officers and the failure on the part of officers to appreciate that it was more than ever necessary for them to set to their subordinates a good example in all things.

TRAINING FOR LEADERSHIP.—An article bearing on the criticism that the only kind of training provided in Germany prior to the World War was that necessary to prepare an Army for a war of movement. The author of the original article points out that movement and nimbleness of mind and body—the latter qualities being fostered by mobility—are the principal means by which, in a military situation, inferiority in numbers can, to some extent, be neutralized. On these grounds the pre-war methods of training practised in Germany are held to be right. At the same time, the suggestion is thrown out that the strength of the forces—some three or four Army Corps—employed in the normal autumn manœuvres may possibly have been too small, and the view is expressed that the ease with which a force of these relatively small dimensions was handled in mimic warfare may have been responsible for creating a totally false impression of the difficulties which would inevitably arise, in view of the enormous technical developments of recent times, in conducting a real campaign with the enormous numbers of troops which take the field in a modern war. False lessons learnt in

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these circumstances may, it is argued, have exercised a prejudicial influence on the German leaders in the measures adopted by them during August and September, 1914, in the initial stages of the World War.

THE FUNDAMENTALS OF INFANTRY TACTICS.—An anonymous article contributed by a "young officer," who points out that the Peace Treaty deprives Germany of three important weapons: "heavy artillery, aircraft and tanks." He restates the factors which play the most important part in the planning of a modern battle, the element of surprise naturally being one of them; he seems fearful lest German statesmen and military leaders may overlook one essential requirement, namely, the provision of the "Ersatzmittel" needed to replace the weapons aforesaid taken away by the provisions of the Treaty of Versailles, which presumably has some day to be treated as a "mere scrap of paper."

THE ENGLISH HISTORY OF THE NAVAL WAR.—A brief review of *Naval Operations*. Vol. II. By the late Sir J. Corbett. The comments refer mainly to the Dardanelles Expedition.

No. 5.—*July, 29th*, 1922.

THE WAR OF IDEAS, CATCH-PHRASES AND PARTY BANNERS.—A plea by Lieut.-General v. Altrock for unity among the German people. The General feels that the great need of the moment in his country is sound intellectual guidance; instead thereof, his compatriots are having flung at them mystic catch-phrases and obscure ideas. The situation thus created is one fraught with considerable danger, since every person interprets the phrases and ideas which he hears in that sense which best fits in with his own particular bias. It is, says the General, only by a combination of effort by all his compatriots to secure a common end that the future of the Fatherland can be assured. His exhortation to his fellow countrymen is expressed in the following terms: "Away, then, with strife under party banners; away also with the war of catch-phrases and abstruse ideas!"

HANS DELBRÜCK *versus* LUDENDORFF.—A bitter attack by Dr. Karl Berger on the well-known German historian and politician, Delbrück, for the criticisms contained in the latter's work, entitled *Ludendorff's Selbstporträt*, on Hindenburg's famous Chief of Staff. Dr. Berger calls in aid two works by retired officers published recently for the purpose of vindicating the character and reputation of Ludendorff, *viz.*, *Hans Delbrück—ein Porträtmaler*? by Lieut.-Colonel Wolfgang Fœrster, and *Ludendorff als Mensch und Politiker* by Lieut.-Colonel Hans Eggert. The two soldier-authors having taken up cudgels on behalf of Ludendorff and soundly trounced Delbrück, Dr. Berger now comes forward to proclaim their great victory.

AMERICAN ESTABLISHMENTS.—Particulars relating to the armament authorized for the Anti-Aircraft units of the U.S. Army.

THE RED ARMY.—A few details relating to the armament, etc., of the "Reds" in Russia.

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No. 6.—*August 5th*, 1922.

Monarchists and Republicans.—An appeal by Lieut.-General v. Cramon for mutual forbearance towards one another on the part of the members of the two great groups into which Germany is divided to-day. With the wonderful pair of field-glasses with which the General has provided himself, he discerns that it is neither on the right nor on the left that the enemies of his country now stand ; it is " in the first line " that the external foes of the Fatherland are at the moment assembled and threaten its very existence. In these circumstances Germany cannot to-day do without the aid and succour of a single one of her citizens, be he monarchist or republican ; her sons must show a united front in order that a brighter and untrammelled future may be won for the Fatherland.

JUDGMENT OF THE COURT OF HONOUR *in re* LIEUT.-GENERAL SCHEUCH, MINISTER FOR WAR.—A somewhat lengthy account of the proceedings of the Court of Honour assembled at the instance of Lieut.-General Scheüch to examine into the several accusations made against him and the alleged calumnies uttered in connection with his conduct in October and November, 1918, during the tenure by him of the position of Commander-in-Chief of the German Home Defence Army. The several matters in relation to which evidence was taken before the Court and the findings in each case are set out. The Court pronounced an acquittal in respect of the whole of the charges and declared that the General's escutcheon was untarnished and spotless. The Court also expressed the opinion that, rather than censure, the General merited the thanks of the Army ; he had proved himself a faithful servant of his Kaiser and Fatherland, and also a blameless officer.

PUBLICITY AND THE REICHSWEHR.—A word of advice to the Officer Corps on the desirability of its members avoiding participation in public in political movements and matters, which may identify them individually with one or other of the political parties in the country. In private, it is fully recognized that officers to-day, as in days gone by, retain complete liberty of action, and may hold whatever political views they may wish.

THE FRANCO-GERMAN CRISIS OF 1875.—A review of the book entitled *Forschungen und Darstellungen aus dem Reichsarchiv*, by Dr. Hans Herzfeld. Since the outbreak of the World War in the autumn of 1914, the view has widely prevailed in foreign countries that the available evidence all points to the fact that the responsibility of having set the conflagration in Europe alight rests on Germany. German writers, of course, contest this view, and also contradict the statement that in the year 1875 Bismarck contemplated springing another war—a " preventive war " (*sic*)—on France, because in his opinion the Republic was recovering too rapidly from the effects of the knock-down blow administered five years earlier by her Eastern neighbour. With a view to proving that his country did not harbour any such evil design as attributed to it, Dr. Herzfeld has apparently been rummaging among State papers in Berlin ; he announces in the book under review that he has failed to find among the papers to which he has had access any document, memorandum, or writing containing any project or plan of

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campaign for an attack on France prepared by von Moltke at the period in question. *Ergo*, no such wicked idea as a "Präventivkrieg" can have been under the consideration of the advisers of Kaiser Wilhelm I, as alleged.

No. 7.—*August 12th*, 1922.

No More War—Away with the Reichswehr?—An article by Lieut.-General v. Altrock commenting upon a contribution, opening with the catch-phrase "Nie wieder Krieg," by the Social Democrat Winnig to the *Dtsch. Allg. Zeitung*, No. 325. Winnig apparently desires to substitute for the cry "No more war," a call to the proletariat of all lands, urging them to unite with a view to preventing the enforcement on Germany of the provisions of the Treaty of Versailles. General v. Altrock thinks, and he may not be mistaken, that Winnig's call will fall on deaf ears. The General is somewhat concerned, at the same time, lest the cry for the abolition of the Reichswehr may meet with success; it would seem that this organization has been openly attacked in the German Press as being a costly encumbrance, etc. The General, on the other hand, considers that it is the first duty of every German citizen to uphold the Reichswehr.

CAVALRY IN THE WORLD WAR: FRENCH VIEWS.—An article by Lieut.-General v. Poseck, Inspekteur der Kavallerie, who takes strong exception to the strictures passed by General Féraud, Inspector General of Cavalry in France, on the German cavalry, in a contribution to the *Revue des deux Mondes* of June 15th last. General v. Poseck seems particularly to be annoyed that the French General should have contrasted the work of the French cavalry and that of the German cavalry in such a manner as to throw added lustre on the former, and quotes from Hanotaux's *Histoire de la Guerre de* 1914 and from the work by Colonel Egli, entitled *Der Aufmarsch und die Bewegung der Heere Frankreichs, Belgiens, und Englands*, in order to prove that the handling of the French cavalry was not altogether faultless. The cause of all this pother is no doubt rooted in the fact that the German cavalry has not come out of the World War with the wonderful reputation which it acquired in the 1870 campaign. (*To be continued.*)

THE GERMAN AIRCRAFT INDUSTRY AND THE ENDLESS WAR.—A complaint against the restrictions imposed on Germany by the Treaty of Versailles in connection with the manufacture of aircraft. It is stated in the article that, in accordance with the terms of the Peace Treaty, Germany has already surrendered 14,000 flying-machines and 27,700 aircraft motors. The claim is put forward that the German aircraft industry should be freed from servitude and that Germany should be at liberty to compete without any restrictions in the markets of the world.

GERMAN PROPAGANDA IN 1918.—A statement relating to the leaflets broad-casted by aeroplanes on the Western Front by the German Propaganda Bureau in May, 1918, with the purpose of shaking the morale of the French soldier. The German peace conditions offered at the time to France were set out in the leaflet and are reproduced in the *M.W.B.* article. The readers of that journal are requested to compare the favourable terms of Germany's offer with the harsh conditions

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imposed on Germany by the Peace Treaty. Yes, but there is sometimes a vast difference between the promise and its performance, and the *poilu* was clever and sharp-witted enough to recognize this fact, particularly when he knew the quarter from which the promise came.

W. A. J. O'MEARA.

REVUE DU GÉNIE MILITAIRE.

January, February, 1922.

Permanent Fortification during the War.—By General Benoit. The article opens with a short history of fortification, and then describes the different practices of various European Nations as regards modern forts. The French place the bulk of the guns outside the forts; the few placed in them are specially protected, and are destined for a special object, possibly the flanking of the intervals.

The Russians followed the same practice till 1912, when they adopted the Belgian system, in which the guns are placed in independent turrets inside the forts.

The Germans followed the Belgian system, but grouped several turrets to form batteries, and in addition allowed for Artillery in the gaps between forts. Flanking fire by specially told-off guns only began to be arranged for by the Russians and Germans after 1909. The thickness of armour varied in the different countries. France was using 30-cm. special steel, lined with 3-cm. sheet steel, and employed disappearing mountings.

Germany had turret mountings, 16-cm. armour with a 4-cm. lining, Belgium, 20-cm. armour with a double lining, each 2 cm. thick.

Concrete.—The French protected old works by thickening the masonry with 1 metre of sand and 2½ metres of concrete (400 km. of cement to the cubic metre). The other European nations used weaker concrete (250 km. of cement to the cubic metre), and smaller thicknesses. For new works, the Germans used, at first, 3 metres of plain concrete, and later, an inner layer of concrete faced with 50 cm. or 1 metre of ferro-concrete. The French used up to 1·80 metres of ferro-concrete. Belgians, Austrians and Russians used weaker concrete and smaller thicknesses than the Germans.

DEFENCE.

France.—Formerly, important towns alone were protected by fortification, and no *liaison* was maintained between them.

Later, forts were placed in districts, such as the north of France, on the main roads leading into the country, with the object of delaying the enemy by forcing him to besiege each in turn.

About 1816, General de Maureilhan expressed the opinion that fortresses should cover an area from which armies could sally to oppose the enemy; one fortress would be quite insufficient for this and that, therefore, fortresses should be in groups.

This idea began to be carried out, after 1870, by General Séré de la Rivière. A continuous line was not aimed at, but fortified regions were created as close as possible to the frontier to keep under artillery fire all the more important road and railway approaches. Gaps were

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left through which the invader was intended to advance, when he would be liable to attack in flank from armies collecting under the shelter of the fortified regions. The three gaps left on the Franco-German Frontier were those of Charnes, Stenay and the Oise. If the enemy beat off the counter attacks, and advanced through these gaps, it was intended that he should find a second line similar to the first. This line was not completed, except the positions of La Fère—Laon—Rheims.

Germany.—The above ideas were copied by the Germans when they built the fortified regions of the Moselle and of Alsace. The gap between was reduced to 20 or 30 km. along both banks of the Sarre.

The second line was the fortified line of the Rhine.

Belgium.—In 1855, the Belgians realized that many small fortified towns merely absorbed their available men, and decided to be satisfied with defending the Meuse. With this object, they built Liége and Namur, and connected them together by the small fortress of Huy. These towns had no enceinte, and only a single ring of forts. Much dead ground lay only 12 km. from the town, affording positions for the enemy artillery. No arrangements had been made for flanking fire or for the defence of the intervals between the forts.

In addition, the forts did not cover with their fire the whole length of the Meuse, only 130 yards wide and easily crossed in many places. One other fortress was built, namely, Antwerp, to act as a pivot of manœuvre for the field army, and as a keep in the event of defeat.

Russia.—Russia had likewise been content to defend the principal crossings over rivers running parallel to its frontiers.

THE STATE OF OPINION AS REGARDS THE FORTIFICATIONS.

The Germans had not completed the fortifications of the Alsace-Lorraine front in 1914, but nevertheless, they realized their importance in giving them the possibility of a very powerful offensive base against France, and the power of either placing all their troops in Alsace-Lorraine or only a small force there with the rest advancing through Belgium against the French Northern Frontier.

The German estimate of the French defences can be seen from the following :—

In 1879, the Emperor of Germany, in a letter to Bismarck, stated that the French front was nearly hermetically sealed, and that even if a breach were made, a pursuit, as in 1870, would be out of the question until the fortified regions had been captured.

Moltke's plan of campaign was an attack through the gap between Epinal and Toul. Waldersee, his successor, had the same plan, but recognized that the organization of the field positions at Nancy and Baddonviller had to be captured first, and that the whole problem was a very stiff one.

Count Schliffen, who succeeded Waldersee in 1891, decided that the position must be turned through either Switzerland or Belgium. The former was undesirable, and therefore, the latter was decided on as a military necessity.

This argument was put forward to the British Ambassador on August 4th, 1914, by Mr. de Tagow, German Minister of Foreign Affairs.

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Germany, fearing much loss of time in attacking the French forts, invaded Belgium to attack the French Northern Frontier which was not in a state to offer resistance. This invasion of Belgium brought England immediately into the war and, therefore, it can be stated that this was done by the fortifications on the French Eastern Frontier. This alone justified the money spent on them, which, indeed, only amounted to the cost of three or four days of the war.

France.—In 1911, French opinion was that wars would be short and decided in two or three large battles. Some forts would be necessary to cover mobilization, but that, apart from exceptional cases, forts to fulfil other rôles would not be required, and that the defence of the country must be carried out by Field Armies.

For these reasons, certain fortresses, notably most of those on the Northern Frontier, were disarmed. Lille, whose disarmament was proposed, but never carried out, was declared an open town on 24th August, 1914. The fortresses retained, whilst blocking the approaches within their reach, were to protect the screening forces until they were strong enough to protect themselves, when they were to act as supporting points, and to cover the concentration of the Field Armies. If these Armies were forced to retreat, the fortresses were intended to threaten the enemy's communications, and to deny him the use of the railways within reach of their armament.

The Rôle Played by the Fortifications in Belgium.

At *Liége*, the last forts to fall had resisted for 12 days in all, and only for three or four of bombardment by 420-mm. guns.

Namur, attacked on the 20th August, fell on the 26th, chiefly owing to the destruction wrought by the 300 and 420-mm. guns. The fort of Emines, for instance, was bombarded by two batteries of 305, and one battery of 420 from 0400 hours to 1630 hours, with the result that three heavy turrets out of four, and two small ones out of three were put out of action.

Antwerp was masked to the south by the 3rd and 9th German Corps on the 21st August.

On the 25th a Belgian sortie was attempted with no permanent success, except to draw back the 4th German Army from its march south.

On the 4th of September, a German assault failed, and on the 9th, the Belgians attacked again. They had some success, but German reinforcements and heavy artillery drove them back by the 13th. The reinforcements consisted of the 6th Division and 9th Army Corps, diverted from their march towards the Aisne.

After this the Belgians, moving by roads still unclosed, effected a junction between their armies and the French, leaving Antwerp with only its garrison.

The Germans brought up their heaviest artillery and began their attack on the 28th September. Antwerp fell on the 10th October.

Remarks.—(i).—The Belgian fortifications fulfilled their rôle as far as their defects and the small number of their defenders permitted.

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The small Belgian army could not hope, even with the help of fortifications, to stop the German advance, but these fortifications delayed it sufficiently long to permit the French to complete their change of front.

(ii).—The defences of the Meuse (two fortresses 40 miles apart, affording each other no mutual support) were insufficient.

These could not prevent the river being crossed, and an obstacle, however serious, has no value if unswept by direct or flanking fire.

The rôle played by the fortifications in Russia and in Austria.—Details are given of the fighting in 1914, the sieges of Przemysl, and at the fortresses on the Memel, Bobr, Narew and the Vistula.

The rôle played by the French fortresses at the beginning of the war.—The first fortresses encountered by the Germans were old-fashioned and untenable, and most of them the French did not attempt to hold. Longwy held out under attack from the 21st to the 26th August when, all the shelters having been rendered useless, and the Germans preparing an assault, the fortress surrendered.

Manonvillers.—The German heavy artillery took up positions 8 km. and more from the fortress, outside the reach of its guns. The steel turrets were destroyed the first day; observation became impossible, owing to the heavy smoke and dust, and the mounds of earth thrown up in front of the embrasures.

It was found that the garrison ran the risk of being asphyxiated by the fumes from bursting shells admitted through the ventilators.

This fortress had been strengthened with reinforced concrete, and the material damage done was not considerable, only three of the garrison were killed and nine wounded; the moral effect of the heavy bombardment was such as to stun the men, and almost to deprive them of their reason. The fortress was bombarded from 0930 hours on the 25th, to 1530 hours on the 27th August.

Maubeuge held out for 13 days in all and eight of intense heavy bombardment. The forts on the north and north-east, being of brick work, were quickly destroyed. Those on the south and south-west were not very much damaged. The fortress held up considerable German forces, which would have been invaluable to them at the battle of the Marne.

The Heights of the Meuse were attacked on the 12th of September, after bombardment with 305-mm. projectiles. The presence of a Field Army and flanking fire from the fort Genicourt enabled the attack to be repulsed. On the 24th and 25th September, the Germans bombarded the Heights on a front of 25 km., between the forts Troyon and Liouville. The Germans crossed the Meuse at Saint Mihiel, captured the fort "Camp de Romains" and the village of Chauvoncourt.

The bombardment did much damage to the unstrengthened forts, the hardened steel turret at Liouville was definitely put out of action.

Damage done to the fortifications.—All the old French forts which had not beeen strengthened were completely destroyed. Ordinary masonry, barbed wire, etc., were useless.

Manonvillers was the only concrete fortress attacked during this

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period, and was afterwards completely destroyed by the Germans, so it is hard to arrive at an accurate estimate of the damage done.

From the reports of witnesses it is believed that the counterscarp gallery was badly damaged by a 420-mm. shell, and a gallery under the ditch was pierced by a 280-mm. shell falling on the same place as a 210-mm. one.

The vibrations set up by repeated bursts, although the concrete was not pierced, caused the sand and masonry to fall into the chambers below.

The Belgian and Russian fortresses, not being so thickly protected or so well constructed, put up very slight resistance to heavy shells. It is known that one 420-mm. shell pierced the concrete roof of a casemate, destroyed it completely and, in addition, the two adjacent ones. —(*To be continued.*)

The Sound Location of Aeroplanes.—By Capt. René Bailland. Some 42 pages deal with the problem in considerable detail.

C. LA T. T. JONES, *Captain, R.E.*

REVUE MILITAIRE GÉNERALE

June, 1922 (*continued*).

The Revision of the Regulations, by "Lucius," (*continued*).—*Sixth period, II.—Application to the German Offensives in the Spring* (*continued*)

From this severe blow (Foch's counter-offensive of the 18th July, 1918) Ludendorff endeavoured to extract lessons, and in a Note of 22nd July stated that, when the enemy received the attack with infantry strongly distributed in depth, and abandoned an advance zone several kilometres deep, more elasticity must be allowed in the execution of the attack to enable it to adapt itself to the enemy's attitude. "To fix details for several hours in advance leads to a breakdown in the system. It is then that the junior commanders below the division must act on their own initiative." Improvements in offensive procedure should be effected under the following heads: (*a*) Counter-battery fire before an engagement may be the shorter the fewer the targets. Rounds must not be wasted by firing on non-existent batteries. On the contrary, after the engagement of the infantry, counter-battery fire must be continued and even strengthened. For this a few batteries must be pushed well ahead, and junior officers will carry out counter-battery fire within their allotted zones of fire. "It may be hoped that for a depth of 7 to 10 kilometres the enemy's artillery, thus threatened, will be sufficiently neutralized to be unable to oppose a serious obstacle to the advance of the infantry and particularly of their regimental guns."

(*b*) Guns firing against infantry need not carry out a long bombardment of the lightly-held trenches of the advanced zone; after partial destruction the infantry should come into action. To this end the preparation preceding the barrage, which is generally directed on the first lines, will be reduced, the use of minenwerfers will suffice, bombardment of the strongly defended lines further to the rear will be prolonged, and should immediately precede the infantry attack. The rolling barrage

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should be less regular, and adapt itself to the ground and positions of resistance, against which a regular preparation should be undertaken. He recognized the difficulty of attaining this, but considered that it should be tried and signals arranged for; after 3 or 4 kilometres a barrage arranged by time-table was bound either to lift beyond, or delay the infantry, and beyond this distance should be carried out by batteries sent forward in good time. However, in spite of improvements in artillery attack, success will depend more than ever on the infantry. The soldier must realize that after he has reduced the first line he will have to fight hard for a distance of several kilometres, where his success will depend on the way he makes use of his own particular weapons, combined with good communication with the artillery and his own alertness.

III.—*Conclusion.*—Thus, in spite of much improved procedure, the Germans failed to shatter the Allied front. Among many reasons for this may be mentioned: (*a*) Their successive attacks followed at too long intervals, about a month, to prevent the Allies from reconstituting reserves. The cause of this was the necessity for moving the guns from one sector to another, and for re-organizing the attacking infantry. If the order had not been given to retain units in action until their offensive capacity was exhausted, it is possible that their reorganization would not have taken so long. (*b*) The rapidity in execution so much extolled by Ludendorff was still insufficient, and this was due to the German infantry losing faith in their success as attack succeeded attack, while at the same time discipline relaxed, and increasing the number of the regimental guns could not revive their waning morale. (*c*) Reserves, as has been shown above, were perhaps insufficient; a superiority of 30 to 35 divisions, or about one-fifth, was not enough to maintain the constant offensives and above all exploit their results. On the other hand, the reserves were not always employed judiciously. On 21st March Ludendorff threw all he had into the balance, while on 9th June he arrested the offensive when he had 40 infantry divisions in reserve under the Bavarian Crown Prince. However, the fresh divisions rapidly decreased in number. Lastly, the 2nd and 3rd line divisions were fatigued by numerous night marches and difficult ground before they became engaged. A means must be found for bringing reserves up at the critical moment as fresh physically as morally. Whatever the results may have been, there is no doubt that Ludendorff's instructions were most apt to the conditions obtaining at the time on the Western Front. They all agreed on putting into practice the great and ever-true principles of surprise, rapidity, and concentration of forces, while extracting the best results from new inventions. All his plans were based on the true notion of the preponderating part played by infantry in the battle. Fortunately the value of the German infantry decreased as its numbers fell, but Ludendorff, great tactician as he was, never realized the value of tanks and cavalry—two fatal errors for Germany.

A. R. REYNOLDS.

(To be continued.)

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THE R.E. JOURNAL.

As already announced, the present number of the *R.E. Journal* is its last appearance as a monthly publication. The first quarterly number will be published on the 1st March, 1923. The *R.E. Journal* was first published, in quarto form, in 1870, and was taken over by the R.E. Institute at the end of 1875. It first appeared in its present form in January, 1905.

ORGANIZATION OF ENGINEER SERVICES.

A Lecture delivered at the S.M.E., Chatham, on 19th January, 1922, by BRIG.-GENERAL W. BAKER BROWN, C.B.

IT is not possible, in the time allotted for a lecture, to go into every detail of such an intricate subject as our Organization for Engineer Services.

All I can hope to do is to lay before you some of the principal points I have noted in my 38 years of service in the R.E., spending a little more time on points which are not fully dealt with in the *Regulations for Engineer Services*, and leaving you to read for yourselves details which are adequately covered in that publication.

There is, however, very little in *R.E. Services* on the general question of organization and there is very little literature on the subject.

I hope, therefore, to be able to interest you in what is really the framework into which all your work as Engineers must fit if it is to be effective.

GENERAL PRINCIPLES OF ORGANIZATION.

Principles of Organization.—The object of all organizations is to enable a number of men to work together effectively for a common object, or, shortly, to get team work. To effect this, such a *body* of men must be given *organs* with varying duties and varying capacity, and experience has shown that, to get good results, the whole body of men must be under one controlling head which may be either an individual, such as Commander-in-Chief, or a corporate body, such as a Council or Board. We have examples of both kinds in our Army organization. Experience further shows that it

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is not possible for one head to control directly more than a limited number of individuals. Napoleon is credited with saying that no man can control more than seven subordinates, and this has been confirmed by experience, while it is generally undesirable to have less than three subordinates, or the controlling authority will not be doing a full day's work.

The simplest form of organization is to group the individuals into squads or parties of about seven men each under a leader or foreman, and then, if the number of squads is more than seven, to bring them together into sections, and then, if necessary, to group the sections, and so on. By this means we establish a chain of responsibility or "chain of command" through which the controlling authority imposes his will on every individual worker.

"Territorial" Form of Organization.—If the work to be done is such that all the units, groups, etc., are interchangeable, we get an organization of the form shown in *Diagram* I. A good example of such an organization is an infantry battalion, with its sub-division into companies, platoons, sections and squads. The only variation possible in such organization is in the number of subordinates which each superior can supervise, and this will depend on the nature of the work to be done, the amount of supervision required at each stage, and the relative capacity of the supervisors and workers. Such an organization is said to be arranged on a "Territorial" basis.

DIAGRAM OF CHAIN OF COMMAND ARRANGED ON A TERRITORIAL BASIS

LINKS OF THE CHAIN ON THE SAME HORIZONTAL LINE HAVE EQUAL DUTIES & POWERS.

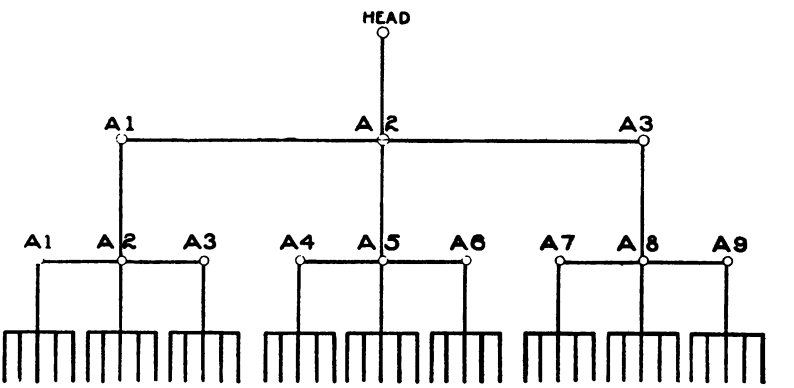

DIAGRAM I.

"Functional" Form of Organization.—When, however, the work to be done can be sub-divided into jobs of a different character, the organization required is not so simple. In such cases the original grouping of individuals will be by qualifications, and groups with different qualifications will not be interchangeable. This distinction

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may be maintained up to the head, and the diagram would take the form of *Diagram* II. The most familiar example of this form of organization is that of an ordinary railway, in which the branches of traffic, locomotion and construction are quite distinct, each under its own Superintendent, all the Superintendents being under the General Manager. Such an organization is said to be arranged on a " Functional " basis.

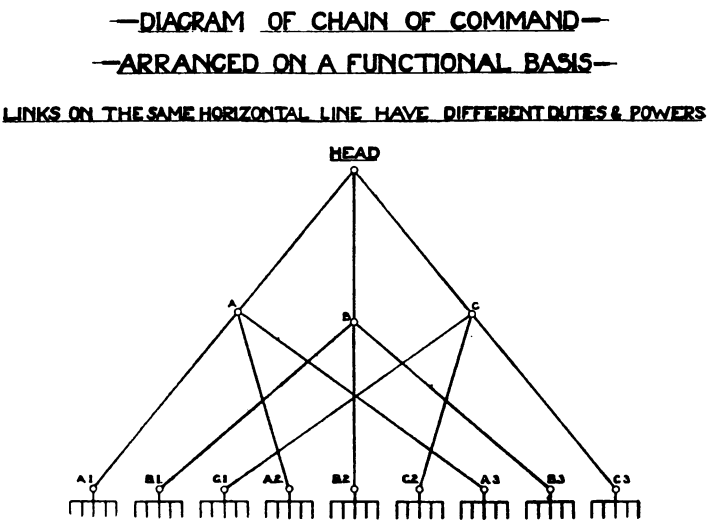

DIAGRAM II.

Combination of Both Forms.—In practice most businesses require a combination of the Territorial and Functional forms of organization, and it may happen that a Chain of Command will take partly one form and partly another. For instance, in an Army Division, the sub-division into Cavalry, Artillery and Infantry is on a Functional basis, but the lower stages of the organization in each case are on a Territorial basis, into Brigades, Battalions, Companies, etc.

The higher organization above the Divisions into Corps and Armies is also on a Territorial basis, but the organization of Administrative Services is usually Functional at the top and Territorial at the bottom.

A further complication arises when, as often happens in the Army, a subordinate Commander of a Technical service is under a Commander of another arm for certain limited duties. For instance, the enforcement of military discipline throughout the Army is, with minor exceptions, on a Territorial basis and does not follow the same Chain of Command as the control of Technical services.

I have laid some stress on the above principles as I have found that, while everyone is familiar with the principles of the Territorial system of grouping, comparatively few officers are familiar with the

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principles underlying the Functional system. In fact, it is only since the appointment of the General Officers in charge of Administration that we have recognized that Technical services require a special form of organization.

The Functional form is most used in civil life, and I anticipate that in future this form of organization will be more fully employed in the Army.

Staff.—It will be noted that in the above descriptions of the "Chain of Command" I have made no mention of Staff, and this for the reason that the "Staff," as such, has no place in the Chain of Command.

The primary conception of a Staff officer is that of a secretary or subordinate who assists with the correspondence of a Commanding officer, and issues orders in his name. Such an officer performs no executive duties and has no responsibility.

In the Navy all secretarial duties are done by a special non-combatant staff.

In our Army the term "Staff" is used, in such expressions as the General Staff or Imperial General Staff, to include a large body of officers who are not true Staff officers, but are performing highly technical duties not covered by any of the recognized arms or Corps of the Army. Such duties include the preparation of schemes for military operations, intelligence, various forms of training, recruiting and the control of movements and quartering. In each of these branches the officers concerned are really employed on executive duties and are organized on a Functional basis. In many cases these officers combine these duties with those of a secretarial nature.

All Technical branches of the Army require a secretarial staff of their own.

Second-in-Command.—Another appointment which may be referred to is that of Second-in-Command. Such an officer must, under our military system, be the next senior officer to the Commander and be ready to act for the latter when absent. He generally is given executive charge of a portion of the duties allotted to the Commander. He is not a Staff officer. A familiar example is that of the Major of a Battalion who relieves the C.O. of many Administrative duties. A few years back it was customary to appoint one of the Staff officers of a Command as Chief Staff Officer, such an officer combined the position of a Second-in-Command with that of a Staff officer. The position is not now recognized in our Army.

Technical Inspectors.—When the technical side of a business is not sufficiently important to justify the complete organization of a technical branch, "Inspectors" are sometimes appointed to visit stations to advise and report on technical questions. Such officers have no executive authority unless such authority is expressly

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delegated to them by their superiors for special cases. There are many examples of this in our Army organization.

Necessity for Putting the Right Man in the Right Place.—However carefully you may arrange any organization, your business will not work properly unless you put the right man in the right place. Everybody has his personal equation, and it is one of the most important duties of the Head of any organization to see that each individual under him is employed to the best advantage.

The method of Army Administration under which the personnel of all Combatant branches is dealt with by the Adjutant-General Staff rather tends to obscure the importance of this point. Once an officer or man is selected for a job, the routine of movement, orders, etc., can be carried out by the " A " Staff, but the original " posting " of the individual must be made by the Head of his branch.

Regulations.—It will be seen from the above that in a complete organization the duties of individuals will overlap to some extent, and such overlapping is unavoidable. Hence arises the necessity of Regulations and Standing Orders.

In the Army, as most of you are aware, there are a good many volumes of Regulations of all kinds, and the casual observer often says, in consequence, that the Army is bound and tied by red tape. Personally I dissent from that view. The issue of Regulations is by no means confined to the Government service. Every business of any importance has elaborate sets of office rules, bye-laws and orders for subordinates. In fact, no business could work without them. Regulations are meant to help, and must be applied with common sense. But no officer or subordinate can be regarded as efficient unless he has a complete knowledge of the regulations of his own arm, and also of the regulations of other arms with which he has to work.

Regulations are of two kinds : those laying down what you have to do, and those laying down what you may not do. The latter are of especial importance in connection with the Chain of Command, as showing what each link in the Chain can do on his own responsibility, and what must be reserved for decision by higher authority.

Necessity for the Use of Identical Organizations in War and Peace.—The above considerations apply almost equally to any form of business, but in the Army we must always keep in mind one other consideration—which may be covered by the saying, " In peace prepare for war." Nothing is more fatal, in my opinion, than a change of organization taking effect on the outbreak of war. The whole object of our existence as soldiers is to prepare for war, and this should be always kept in mind in all our peace work. In the late war we began our campaign with a system of Administrative work in the field which differed in nearly all details of organization from that adopted in peace, and this system was continually patched

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and altered without, however, reaching finality. The organization which we have developed for the R.E. work in peace is, in my opinion, well adapted for our work in war.

DEFINITION OF ENGINEER SERVICES.

I will now consider for a few minutes what is the nature of "Engineer Services." Engineering is a very wide term, and might be defined as any form of activity which is devoted to controlling the forces of nature for the use of man. But in the Army certain forms of engineering are allotted to special corps and are no longer carried out by the Royal Engineers. Among these are included "Artillery and the manufacture and use of explosives for offensive warfare in guns or rifles," "Mechanical Transport," "Flying," and "Signals." The first split off from the Engineers about 200 years ago; the last three have been handed over by our Corps during the last 20 years.

There are also some Engineer Services, such as the construction of vehicles, which are carried out by the R.A.O.D.

During the late war the services connected with Railway work and Transportation were formed into a separate Transportation service and the services connected with Forestry and the supply of timber were also given a separate organization; but the amount of Engineer work left to the E.-in-C. was very large indeed.

Division of Engineering Work.—This may be best considered, not by the results to be obtained, *e.g.*, Bridging, Mining, etc., but under the ordinary civil grouping of engineer work as performed by Architects, Engineers, Quantity Surveyors, and Electrical and Mechanical Engineers. Some knowledge under all these heads is necessary to a Military Engineer, whose motto should be "Jack of all trades and Master of one."

The last two headings are of rapidly growing importance and include the large group of services connected with the use of electric lights for coast defence and against air-craft. They are very technical and require rather special training. Quantity surveying is also technical, but I will deal with this later. There remain the two heads of Architecture and Engineering which, between them, constitute the larger part of the work of the Royal Engineers.

Some of you may wonder how I can reconcile the inclusion of Architecture with the close connection which I want to uphold between duties in war and peace, and may hold the opinion—which I consider heretical—that the work of the Architect in the Army should be done by a non-combatant branch and not by the R.E. Such an opinion is often based on the idea that the duties of an Architect are mainly concerned with producing a good elevation of a building; this is not the case, an Architect is primarily a builder,

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and is responsible for all details of buildings with roofs, from their foundations upwards, including details of construction and the use of materials, and also the arrangements for distribution in the building of water, light and drainage. The Civil Engineer, on the other hand, carries out engineer work other than building, such as schemes of water supply, disposal of sewage, roads, bridges, power-stations of all kinds, railways, canals, wharfs, docks and similar services. For the Military Engineer we must add Fortification.

Now both the Architect's and Engineer's work are of great value to all Military Engineers, both directly and indirectly.

Take the latter point first; we want, in our Military Engineers, to encourage the soldierly qualities of quick decision, a good eye for country, and the will to take responsibility, but all these will be useless unless behind them there is sound knowledge of Engineering principles and details. Further, this knowledge must be backed by much experience of practical work, and this can only be obtained by the execution of definite jobs. It is here that the R.E. has the advantage of the regular soldier, the latter cannot practise his full trade until the bullets begin to fly, while every job of work gives training and experience to the Engineer.

But our training as Architects has also a direct value in military operations. One of the most essential details to attend to in all campaigns is the health of the troops, and this depends on the careful carrying out of a lot of details. Of these, good and sufficient food is, perhaps, the first, and for this the R.E. are not responsible. But they are interested in the arrangements for cooking the food, the supply of good water, sanitary services, the provision of dry and warm accommodation in billets, camps or huts, and the provision of hospitals, laundries, bakeries and many other things. The Medical service is, of course, responsible for advice on all such questions, but the Engineer's is the executive hand which gives practical effect to such recommendations. Even at the front such questions form a very large part of the work of an R.E. officer, and behind the front line the work on accommodation is our primary duty. In such work we could not wish for a better training than that involved in the construction and maintenance of barracks in peace. The latter gives an unequalled opportunity for the study of every detail such as water supply, drainage, lighting, heating and cooking that may be required in the field.

As an example, I may refer to my own experience during the war as Chief Engineer Eastern Command.

In the summer of 1915 we had 550,000 men in the Command, and in addition to huts for about 200,000 men and barracks for 70,000 we had to arrange tented camps for 250,000 men in 250 localities. These camps were permanently occupied for the whole summer—seven months. The ordinary rules for camps laid down in camping

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manuals were quite inapplicable to the conditions. Every camp required a good water supply distributed throughout the camp, hot baths and ample cooking accommodation. Trench latrines were barred, and we had to instal a bucket system, or in some cases a water carriage system with treatment tanks. Without a sound knowledge of civil practice such a task would have been impossible.

Now a word as to Quantity surveying. Put shortly, this is a technical method which has been developed in the course of experience for the measurement and payment of engineer work which is performed by contract. To learn the schedule thoroughly and how to use it is essential for all architects, and such study incidentally provides a liberal education in the methods of work and the relative importance of different items and trades. While this method is of most use in peace procedure it is by no means negligible in war time, when economy of money and material is as important as it is in peace. Even in the fighting area itself, civilian labour has constantly to be employed and much of the work behind the front is done by contractors. Of course, under war conditions some of the minutiæ of measurement are dropped, but an engineer officer would find it very difficult to supervise any contract work unless he knows something of the schedule.

As an example of the importance of contracts in time of war I may mention that, in the Eastern Command in 1915–1916, about 3,000 contracts a year, made by C.R.E.'s and D.O.'s, passed through the C.E.'s office for review, and this excludes small contracts, under £100 each, reviewed by C.R.E.'s.

The alternative to contract work is the use of direct labour supervised by R.E. In this case the labour is often civilian and the R.E. officer is in the position of the contractor.

Lands.—There is one other technical branch of our work which must be considered, and that is the group of questions connected with lands and property.

Normally the R.E. are the responsible custodians of all Government property in lands and buildings. They hold the legal documents on which the possession of such property is based, and the Chief Engineer of a Command has special authority, which used to be given personally to each individual, to sign deeds, transfers, etc., in the name of the Secretary of State for War. During the war the transactions connected with land and buildings became very numerous, and a very large increase had to be made in the staff of the Lands branch.

In France the work became so important that a special Directorate was formed under a Major-General to deal with such questions.

Engineer Stores and Workshops.—In connection with Engineer work it is necessary to maintain in every area a stock of stores and tools and to provide an organization for the purchase of stores other

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than those supplied by contractors as part of a contract. Whenever military or direct labour is employed, workshops with machine and hand tools are required.

During a war overseas, the supply of stores becomes very important, and special attention must be given to the organization. During the late war the organization for stores and workshops in France increased continually until it was raised to the status of a Directorate, with a Brigadier-General in charge.

Personnel.—Our organization must also provide for the command and control of the personnel allotted for each command. This may include :—

Staff for R.E. Services.
R.E. Field units.
R.E. Works units.
Civilians permanently employed.

The Staff for R.E. Services is a military body of officers, warrant and non-commissioned officers, specially formed for dealing with certain technical branches of our work, and is, in some respects, outside the regular regimental organization of the R.E.

The officers are obtained by promotion from the ranks of the R.E. and are divided into two classes—Quartermasters and Assistant Inspectors of Machinery. The latter are selected from the various classes of mechanists referred to below, the former are selected from foremen of works, mechanists or warrant and non-commissioned officers on the regimental list. Quartermasters promoted from foremen of works are usually employed in control of works, the others are employed in charge of stores, in performing the duties of regimental quartermaster, or in special technical work, according to qualifications.

The subordinate staff of warrant and non-commissioned officers is selected from the ranks of the R.E., or may, in some cases, be specially appointed from civil life. It includes clerks, draughtsmen, foremen of works, store-keepers and electrical and mechanical mechanists, the nature of the work done in each case being indicated by the title.

Under the officers, this group of subordinates forms the backbone of the Engineer Works Service. The standard of qualification obtained by individuals is very high, and I should like to take this opportunity of testifying to the valuable services and the unfailing support which I have always received from these members of the Corps.

Field Units.—The R.E. field units are maintained primarily for duty with a force in the field, and their establishment and organization are settled accordingly. They usually form part of a Division of the Field Army. Such units necessarily spend a good deal of the

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year in training for field duties and in assisting with the training of other arms of the Division. But in order to maintain the technical skill of the tradesmen in these units, and to give officers and other ranks practical experience in carrying out work, the C.R.E. of the fighting Division and field units should be included in the works organization of the area in which they are quartered.

Works Units.—R.E. Works units include two classes: (1) men trained in the special duties connected with defence electric lights and telephone service in fortresses, and (2) men of ordinary trades employed on fortification and other Works services; men of class (1) can also be employed on Works. These two classes are combined into suitably sized companies, according to the size of the Garrison to which they belong. These companies always remain at the same station in peace and their reliefs are effected by drafts. It should be noted that the companies are in this case only administrative and not fighting or working units.

Civil Staff.—The civil staff—many of whom are pensioners or reservists—includes clerks, foremen, technical superintendents of all kinds, engine drivers, boiler attendants, land bailiffs, caretakers, messengers and so on.

In connection with these, one of the most important questions at the present day is the fixing of a fair rate of wages. It is a definite principle of Government policy that the rates of wages paid to all subordinates and the hours worked shall conform to those prevailing in the locality, and moreover, the Chief Engineer in a Command is responsible for ensuring that the wages paid by all civilian contractors employed by him are the standard rates of wages of the District. At the present time these rates are discussed and controlled by a series of Committees and Councils centring in the Ministry of Labour, and it is necessary for the R.E. to keep in touch with each link in that chain. The work involved is very considerable, and in my last Command in Ireland I found it necessary to detail one officer of my staff solely to deal with labour questions.

The arrangement for the Command and control of the staff will be apparent from the next section, but one point of organization I may mention here which saves a good deal of work. The military subordinate staff are, of course, soldiers and are treated as such, and they have the usual military documents which have to be guarded. If a separate pay and clothing account is kept for this staff, some member of the staff has to be detailed to keep these accounts and the same procedure has to be followed for, say, six men as would suffice for a unit of 200. My suggestion is, therefore, that whenever a unit of R.E. is available in the area, the military staff should be attached to the unit for discipline and administration. The addition of a few names in the pay list, etc., makes little difference to the company staff and one complete set of accounts is saved.

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Organization for R.E. Services.

And now I can go on to the main subject of this lecture, the Engineer organization actually adopted in the British service. Broadly speaking, this is based on a Territorial distribution for the ordinary duties, coupled with a Functional distribution for technical services.

The organization in India, though based on similar principles, differs somewhat from that in force in England, and as I am purposely basing this lecture on personal experience and I have never served in India, I have omitted all details of that country.

I may say here that some details of the organization are under consideration at the War Office and I must rather be taken as describing what exists as an illustration of the principles I advocate than as attempting to forecast the future form of the R.E. Regulations.

The principal links in the Chain of Command for Works are the Chief Engineer, Commanding Royal Engineer, and Division officers. One Chief Engineer is appointed to each of the Commands at home and to Gibraltar, Malta and Hong Kong abroad. They have the rank of Colonel-Commandant or Colonel, according to the size of the station. The Chief Engineer is the head of all the Royal Engineers in a Command, he administers the R.E. services of the Command, ascertains the requirements, obtains W.O. approval and funds, and distributes these funds to C.R.E.'s. He inspects throughout the Command.

Under the C.E. each command is usually divided into two or more Districts, each under a C.R.E., who is responsible for the executive work connected with the expenditure of the funds allotted by the C.E.

Under each C.R.E. the District is divided into Engineer Divisions, each under an experienced officer of Engineers called a "Division officer," who is responsible for the executive work connected with the expenditure of the funds allotted by the C.R.E. A Division officer has often one or more assistants, but the Division is the lowest link in the chain of organization for works and may be considered as the "unit" of our works organization.

There are a few exceptions to the above. In some of the fortresses abroad there is not enough work to justify more than one C.R.E., while the total duties of the R.E. are too heavy to be done by the C.R.E. alone. In such cases the duties are divided between the C.E. and C.R.E. in rather a different way. I give an illustration of this on p. 349. In the case of the large fortresses at home, the work before the war was so large that two or more C.R.E.'s were required. In these cases a special Chief Engineer was appointed to control and co-ordinate the work of the C.R.E.'s in the fortress. With the recent reduction of coast defences these appointments are now

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abolished. In small stations abroad there is no C.E., and the C.R.E. combines both sets of duties.

Chain of Military Command.—The chain of military command in the R.E. has also three stages—the Chief Engineer, C.R.E. and O.C. Company. The Chief Engineer of a Command has much the same military duties and responsibilities as a Brigadier of an Infantry Brigade. He controls the distribution of all officers and other ranks throughout the Command, whether belonging to the R.E. Staff or units, but as the R.E. organization necessarily covers the whole Command, the R.E. personnel is always scattered, so that some subjects, such as training and discipline, which are dealt with by an Infantry Brigadier, are not dealt with by the Chief Engineer personally, but are delegated to C.R.E.'s.

The duties of C.R.E.'s correspond closely to those of a Lieut.-Colonel commanding a Battalion of Infantry, subject to the same principle of delegation in the case of companies on detachment residing away from the C.R.E.'s Headquarters. When two or more Companies are quartered in the same barracks, a battalion organization is formed by detailing an officer or officers as Adjutant and Quartermaster and by attaching a regimental staff—usually a Regimental Serjeant-Major and a Quartermaster-Serjeant. It will be noted that a Division officer, unless he is also the O.C. of a Company, only commands the members of the R.E. Staff who are placed under his orders, but if he is the senior officer of R.E. at an out-station a Division officer would be the O.C. R.E. of the station for all local purposes. The above organization is, of course, subject to exception, for instance, the depôt and schools at Chatham have a special organization. Cases may also occur such as the reconstruction of a barrack, where it may be necessary to appoint special officers as D.O.'s and even C.R.E.'s of such reconstruction, and such officers may be left outside the military chain of command.

But, exceptions apart, the two chains I have described for "works" and for "military command" form the backbone of our organization, and the nearer these two chains can be made identical, the closer we shall get to the ideal combination of engineer and soldier which makes the Royal Engineer.

Division into Areas.—Before discussing the functional part of our organization I may here say a few words on two points affecting the above organization which are closely allied to one another:—

(1) The subdivision of a Command into R.E. Districts and Divisions.
(2) The relations of the R.E. organization to the general organization of the Command.

The subdivision of a Command into Engineer Districts affects a great many interests and the final decision is reserved for War Office

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approval. In peace time changes in these areas are few, but during the war it was necessary to make many changes, and I may lay down a few general principles based on my own experience. These principles may be of value in arranging the R.E. districts on the L. of C. The first principle has already been referred to, that the number of C.R.E.'s supervised by one Chief Engineer must not be excessive; when the C.E. is single-handed, three or four C.R.E.'s can be usefully supervised by one Headquarters, and if the number of C.R.E.'s required is over four, the C.E. will require a deputy in his office to relieve him of some of the routine and to enable him to make personal visits to out-stations. Similarly, C.R.E.'s cannot usefully supervise more than three or four D.O.'s.

Secondly, in arranging the area of C.R.E.'s districts, it is, in practice, necessary to consider the subdivision of the Command for military purposes, and also the areas adopted by the R.A.S.C., R.A.M.C. and the other administrative services.

The larger Commands at home are now divided into Areas, each under a General Officer. These officers have no power to order services. But it is obviously convenient that the area controlled by each C.R.E. should be wholly within the area commanded by one General. If such an area contains so much Engineer work that it has to be divided into two or more Engineer Districts, then the whole of both Districts should be in the one General's Command. In practice, however, there are many exceptions to this principle. Theoretically, there is no reason why in such cases the two C.R.E.'s in one Command area should not be considered as parallel organizations, just as two or more Infantry Brigades exist side by side in the same Command, and certainly, for military purposes, two or more C.R.E.'s can correspond with one Command Headquarters. But for technical questions, my experience is that such an arrangement gives rise to difficulty. The General Commanding an area and his staff have usually no technical knowledge and like to refer technical questions to one qualified adviser who can deal with their whole area, and this would be especially felt on mobilization or if troops are used to give support to the civil authority. In such cases, either a Chief Engineer or Deputy Chief Engineer should be appointed, or the C.R.E. at the Headquarters of the area must be given some of the powers of a Deputy C.E. and be able to advise the G.O.C. on all Engineer questions in his area.

Similarly, in the case of Engineer Divisions, it is advisable that they shall be coterminous with the areas of stations or other subdivisions of the Command. Such arrangements are not always easy and they may result in making some Districts or Divisions larger than others, and thus produce an inequality of work. Provided this is recognized and the best and most energetic

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officers are appointed to the more difficult jobs, there is even some advantage in such inequality.

I am an advocate for what are termed "large" Divisions, each in charge of an officer of the rank of Major or Captain, officers below Captain being employed as Assistant Division officers. The alternative of many small Divisions with only one officer to each Division has been defended in the past as giving the young R.E. officer responsibility early in his career. The principal objection to it is that it involves a large number of offices and a consequent waste of clerical staff.

As regards other administrative services, the two branches with which the R.E. are most intimately concerned are the R.A.M.C. for sanitary services and the R.A.S.C. for quartering and barrack services. Where there are several R.E. Divisions in one station, it is very desirable that the boundaries should coincide with those of the R.A.S.C. officers in charge of barracks. Similarly it is desirable that C.R.E.'s Districts should coincide with the R.A.S.C. and R.A.M.C. Districts whenever possible.

Relation of C.R.E. to Subordinate Commanders.—Since 1905 Generals commanding areas have been relieved of the responsibility for the efficiency of the administrative services and are able to give their whole time to their military duties and the training of troops. If the General considers the administrative work is not being properly done he would not attempt to improve matters himself by altering the local organization, but would refer to the Headquarters of the Command. On the other hand, the General is responsible for indicating the nature of the work which he wants done and the relative importance of various services, and it is the primary duty of the representatives of Administrative services to carry out the wishes of the G.O.C. as far as may be possible. It may, however, often happen that a C.R.E. (or other head of an administrative service) is unable to do what he is asked, either for want of funds or perhaps because the proposal would give accommodation in excess of the scale allowed, or in some other way would conflict with the orders of higher authority. In such cases the C.R.E. would explain to the G.O.C. that he could not do what was required without further authority, and ask if the proposal could be modified or whether it should be submitted to the H.Q. of the Command. In no case has a C.R.E. or any R.E. subordinate a right to definitely refuse to carry out work, but he has the right to ask that a question may be referred.

I have dwelt at some length on this point as it is an important principle in the working of any functional organization and is not peculiar to R.E. work.

Position of C.E.—The Chief Engineer exercises much of his personal control by frequent visits to all stations, when he will have

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opportunities of personal discussion, not only with C.R.E.'s and R.E. officers, but also with Generals and other officers commanding areas and stations.

The military relation of the C.E. to subordinate Commanders is very much that of a Brigade Commander of Infantry whose units are on detachment and consequently come under the orders of local Commanders for certain purposes while remaining part of the Brigade.

In Commands where there is a General or other officer in charge of Administration, this officer has delegated responsibility for all financial expenditure and the Chief Engineer is responsible to him for the control of the funds allotted for all Engineer services. But in order to ensure that the Engineer side of all questions should be fully considered the Chief Engineer is granted direct access to the Commander-in-Chief of the Command and is usually consulted on all important questions.

At the Headquarters of the Command the Chief Engineer has relations with all the various branches of the staff. With the Military Secretary he arranges all questions affecting Engineer officers such as the posting of officers within the Command. With the representative of the General Staff he discusses questions of defences, engineer work on manœuvres, including camps, and questions affecting training, such as the provision of gymnastic apparatus and all questions connected with rifle ranges. The latter are especially important, as the R.E. are in charge of all rifle ranges and are responsible as regards their safety. With the representative of the Adjutant-General he arranges all questions affecting personnel other than officers, the decision as to where each individual can be employed to the best advantage being made by the C.E. With the representative of the Quartermaster-General he arranges details of barrack accommodation and discusses the best method of using the funds allotted to the Command for barrack repair and improvement.

In arranging the duties of the staff and subordinates in the C.E.'s office it is necessary to consider the above subdivision of duties among the staff of the Command.

Organization of Technical Branches.

Having now discussed the framework of our organization and its relation to other branches, we can consider the best method of fitting in the more technical branches which, as I have said, are organized on a functional basis.

Electrical and Mechanical Group.—The most important of these is the Electrical and Mechanical group. Formerly these two subjects were separately dealt with, but they are very much interlocked and may conveniently be considered together, though the whole of the personnel provided is not interchangeable between the two sides. We have had a special organization for Mechanical work for the

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last 40 years or more. On the completion of the young officers' course a few officers volunteered or were selected for a special course of Machinery, usually carried out at Armstrong's or some civil works. One officer with this training was posted to each Command as Inspecting Officer for R.E. Machinery. In a small Command he may combine such duty with that of a D.O. or of an O.C. Company. In a large Command the I.R.E.M. was a member of the staff of the C.E. Under the I.R.E.M. there were and are a trained body of Machinery mechanists. Some of these are posted to each Command and are distributed at the more important centres so that all machinery in the Command is in charge of some Mechanist.

The Electrical work of the Corps was for 40 years in charge of the Submarine Mining Service, a branch of the R.E. which was specially trained for charge of the submarine defences and defence electric lights. These officers, in addition to their normal duties, were placed in charge of all Electrical work at their respective stations, including telephones and barrack lighting, the senior officer of the Submarine Mining service acting as Inspector of Electrical services. As electric light was gradually introduced in barracks inland, such as Aldershot or the Curragh, selected officers were placed in charge. When the submarine defences were handed over to the Navy in 1905, the R.E. retained control of the Light defences, but as the use of Electricity was becoming more general, a special course at the works of civil firms was arranged for selected officers similar to that for machinery work. Electrician mechanists assist the officers in all classes of Electrical work.

Within the last ten years there has been a great increase in the use both of Electrical and Mechanical machinery, and after the war some changes were made in the organization. There is now in each Command at headquarters an officer in charge of Electrical and Mechanical work who replaces the I.R.E.M. For machinery work a new class of officer has been introduced with the title of Assistant Inspector of R.E. Machinery; they are distributed as required, and this class is being extended to cover Electrical work.

The specially trained R.E. officers are so distributed by the C.E. that each C.R.E., at any rate in the larger Districts, will have under his command an officer who has specialized in Electrical and Machinery work. The two classes of Mechanists work under these officers.

It will be observed that this organization is not extended to Divisions, and where a special officer is appointed for E. and M. work, the R.E. Division officer is only responsible for notifying requirements and is not responsible for technical detail.

Organization for Quantity Surveying.—To deal with this technical subject we have a special class of officer called an Inspector of Works, selected from gentlemen who have expert qualifications in surveying. These officers are not combatant and cannot exercise

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military command. They have necessarily considerable knowledge of constructional work, and most are well qualified to perform the duties of Division officer. During the war these officers rendered the greatest assistance to the R.E., many of them received temporary commissions in the Corps and some performed the duties of C.R.E.

At the Headquarters of each Command, a senior officer of this branch is appointed with the title of Superintending Inspector of Works. This officer checks all bills prepared by C.R.E.'s and is also employed in dealing with the placing of contracts and all questions arising in connection with contracts.

An Inspector of Works is appointed to each C.R.E.'s office for similar duties and also carries out some of the more important measurements, and is available to advise D.O.'s on technical questions. The ordinary measurements are carried out by D.O.'s and Foremen of Works.

Under the Inspector of Works, there is a class of Surveyor's clerks, who are drawn from civil life and have to be specially engaged and paid.

Land Questions.—The control of land questions is at present rather unsettled. Before the war at stations abroad the work was in charge of an R.E. officer in the C.E.'s office, usually the staff officer, assisted by one or more of the Clerks and Draughtsmen on the staff for Engineer services. At home stations this arrangement was supplemented by the appointment of a Land Agent to each Command, who dealt with the technical side of all land and property questions. The Land Agent was not in charge of a branch of the C.E.'s office, but acted as a technical adviser only. The actual custody of land and buildings in all cases devolved on the C.R.E.'s, and the official records or "terriers" were kept by the C.R.E. or C.E. as convenient. The special Lands branch formed during the war is still dealing with the settlement after the war.

I do not see how there can be work for a separate Lands branch in the future, and the work connected with land and property is so intimately connected with the other R.E. work that I do not think the two sides can be usefully separated.

In some cases, where manœuvre ground has been purchased outright, it may be necessary to employ a land bailiff and a staff of labourers to keep the land in order and look after grazing, hedges, ditches, etc. This staff would normally work under the D.O. of the area.

Design Branch.—In connection with the ordinary construction work, it is necessary to provide for the preparation of designs for new services. By the Regulations for Engineer services a C.R.E. is responsible for designs for new services under £500, and the C.E. is responsible for new services of £500 and over. But when this regulation first came out in 1910 no staff was provided in C.E.'s

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offices for a design branch, and in practice all designs were prepared by C.R.E.'s. The latter have, of course, to provide the information on which much of the design is based, such as the local arrangements for water, light or drainage, but the C.R.E. has plenty of other work to do and cannot spare much time for the preparation of designs. But apart from this, I consider that as much designing as possible should be done in the C.E.'s office, as this makes a more economical distribution of staff and, besides, gives the C.E. an opportunity of impressing his personality on the work of the Command. The question of whether a separate officer should be put in charge of the Design branch depends on the amount of new work in hand; in any case a good draughtsman is required for charge of this work and he may want one or more assistants. He will also be in charge of all plans and records in the C.E.'s office. Each C.R.E. will also require a draughtsman for small designs and for charge of plans and records.

R.E. Stores.—The distribution of stores and store charges is an important part of the general organization. It is necessary, in order to reduce transport, to have an R.E. store in each important centre, but where barracks are concentrated several divisions can draw from one central store. We shall, however, require some or all of the following :—

1. One or more central store offices for the Command where a ledger account is kept, and where copies of orders for stores are guarded. In this office the accumulation of stocks is watched so that surpluses at one station can be transferred to other stations where they are required.

2. One or more central stores holding stock for the whole Command. This is mainly wanted at stations overseas and should be located at the port of disembarkation of stores.

3. One central store for each C.R.E.'s District for stores common to the whole District.

4. One Division store for each outlying Division not within reach of the C.R.E.'s store.

The stores in 2, 3 and 4 will each keep an account on tally cards.

5. Expense stores for each foreman of works' charge not within easy reach of a Division store. Such stores do not keep tally cards, but draw small quantities of consumable stores in bulk periodically, usually monthly, and also hold ordinary tools for current work.

To control the above we shall require an experienced officer as officer in charge of stores to take charge of each Central office and to carry out the periodical inspection and stock-taking of all stores. I strongly recommend that this officer, wherever he may be located, should be considered as a direct subordinate of the Chief Engineer.

For each C.R.E.'s District an officer is required as O.C. stores and if no special officer is available one of the Division officers must be

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detailed for this duty, in which case the size of his Division must be curtailed. Division and expense stores are in charge of Division officers and foremen of works.

The central stores office will require several good clerks and ledger keepers, and storekeepers will be required for each tally card store, also one or more storemen for cleaning, moving stores, etc.

R.E. Staff Officers.—To assist Chief Engineers in supervising and directing the above organization, two classes of specially appointed officers are recognized—a Deputy Chief Engineer and a Staff Officer. The Deputy Chief Engineer is allowed only at the four largest Commands at home. He combines the duties of a Second-in-Command and a Staff officer, but his most important function is to carry on the routine work of the office and allow the C.E. to visit and inspect all stations in the Command at frequent intervals. The appointment is gazetted and is filled by an officer on the Colonel's list.

The Staff officer, R.E., is usually a Captain or Major, R.E., specially selected but not gazetted. His duties usually include all the work connected with the military personnel, such as confidential reports, training or the posting of drafts and individuals. In the smaller commands he also performs the duty of a Deputy in the absence of the C.E.

If additional officers are available, one may be usefully detailed to look after rifle ranges and training questions, while the officer in charge of the Design Branch can assist with quartering questions.

Subordinate Staff.—In addition to the special subordinate staff referred to under each branch of work, all offices and branches will require clerks, typists and messengers. It is a common idea that all clerks can be considered as interchangeable, but in practice this is not the case, and each man should, as far as possible, be put to the work he can do best. Practically we recognize two classes of clerks : (1) correspondence clerks, (2) finance clerks. Correspondence clerks deal with incoming and outgoing letters, attend to files, prepare general letters for signature and keep all regulations up to date. Finance clerks keep expense ledgers, and deal with bills, vouchers and all correspondence connected with expenditure. I consider that each Division officer requires at least two clerks, one for correspondence and one for finance, and also a surveyor's clerk if the Division is a large one ; each C.R.E. will require a chief clerk with one or more assistants for correspondence, a good finance clerk and one or more typists.

A Chief Engineer requires a similar but rather larger staff.

Conclusion.

In concluding this portion of my subject I would again draw attention to the necessity of studying the personal equation. For instance, the distribution of work in a C.E.'s office between

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C.E., Deputy C.E. and Staff officer must depend a good deal on their personal tastes and qualifications.

I hope I have been able to show you that the organization for Engineer services can and should include our military organization as soldiers, and our technical organization as engineers, and can and should be applicable in war as in peace. While there may be many perfectly legitimate opinions as to the wisdom or otherwise of many points I have alluded to, there can, I think, be no difference on the main points which I may thus express :—

1. Establish a working organization, thinking out all details.
2. Put the right man in the right place.
3. Lay down a few simple rules to govern the chains of Command and the relative responsibility of each link in the chain.

As an example of the application of the above principles, I attach a diagram of the organization of the R.E. at Hong Kong as arranged on the outbreak of war in 1914.

The garrison of Hong Kong at this date consisted of five companies R.G.A., two companies R.E. and five battalions of Infantry, with a local Volunteer Corps. The perimeter of the area to be defended is about 25 miles in length and is divided into four sections—two land fronts and two defended entrances to the port.

The four R.E Divisions of Kowloon, Peak, Belchers and Lyemun corresponded with the four defence sections, and the D.O. automatically became O.C.R.E. of the section on mobilization. The Victoria Division comprised the offices and barracks at and near Headquarters. I may add that on the outbreak of war the change from peace to war conditions worked perfectly smoothly.

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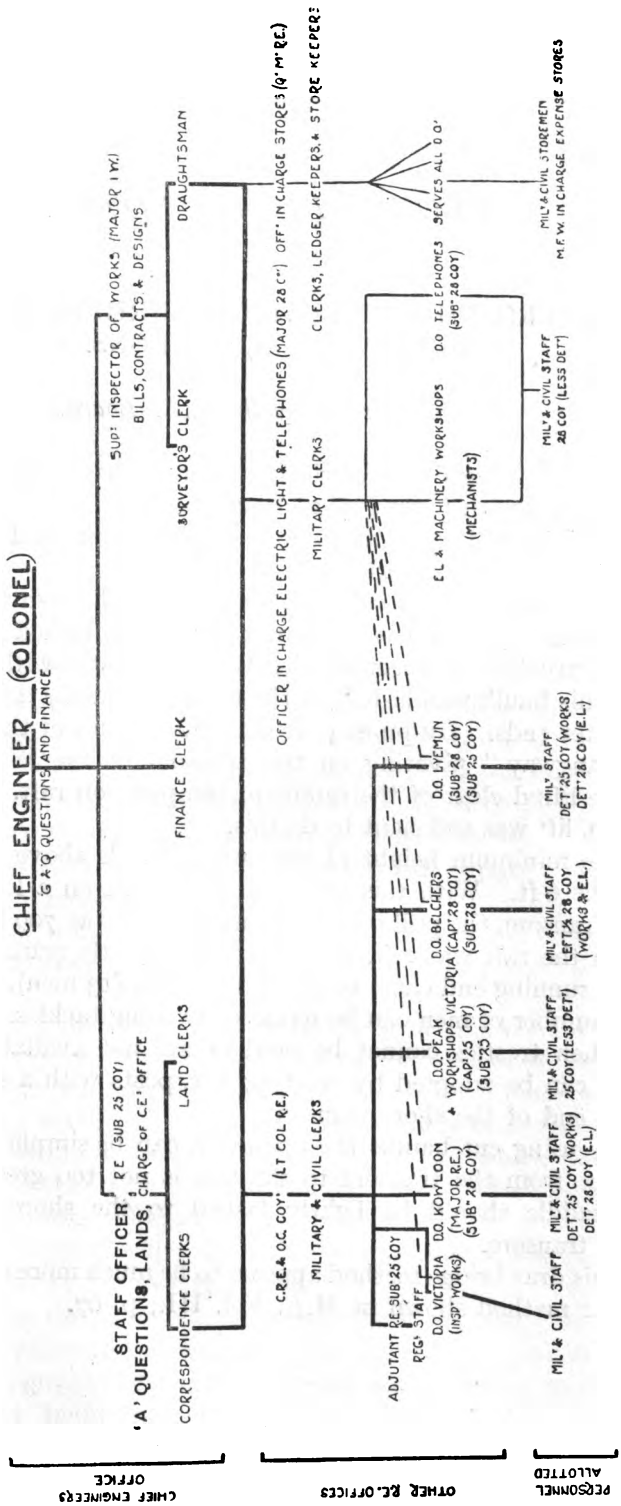
ORGANISATION OF ENGINEER SERVICES.

DIAGRAM OF CHAIN OF COMMAND IN HONGKONG 1914


CHIEF ENGINEER (COLONEL)
G.A.Q. QUESTIONS AND FINANCE
STAFF OFFICER 'A' QUESTIONS, LANDS, R.E. (SUB 25 COY) CHARGE OF C.E.'S OFFICE
CORRESPONDENCE CLERKS
LAND CLERKS
FINANCE CLERK
SUP: INSPECTOR OF WORKS (MAJOR I.W.) BILLS, CONTRACTS & DESIGNS
SURVEYOR'S CLERK
DRAUGHTSMAN
C.R.E. & O.C. COY' (LT COL R.E.)
MILITARY & CIVIL CLERKS
OFFICER IN CHARGE ELECTRIC LIGHT & TELEPHONES (MAJOR 28 COY)
MILITARY CLERKS
OFF' IN CHARGE STORES (Q.M. R.E.)
CLERKS, LEDGER KEEPERS & STORE KEEPERS
ADJUTANT R.E. SUB 25 COY
REG' STAFF
D.O. VICTORIA (INSP' WORKS)
D.O. KOWLOON (MAJOR R.E.) (SUB 28 COY)
D.O. PEAK & WORKSHOPS (CAP' 25 COY) (SUB 25 COY)
D.O. BELCHERS VICTORIA (CAP' 28 COY) (SUB 25 COY)
D.O. LYEMUN (SUB 28 COY) (SUB 25 COY)
E.L. & MACHINERY WORKSHOPS (MECHANISTS)
D.O. TELEPHONES (SUB 28 COY)
SERVES ALL D.O'
MIL' & CIVIL STAFF 28 COY (LESS DET')
MIL' & CIVIL STORE MEN M.F.W. IN CHARGE EXPENSE STORES
MIL' & CIVIL STAFF
MIL' & CIVIL STAFF DET' 25 COY (WORKS) DET' 28 COY (E.L.)
MIL' & CIVIL STAFF 25 COY (LESS DET') MIL' & CIVIL STAFF LEFT 2 & 28 COY (WORKS & E.L.)
MIL' STAFF DET' 25 COY (WORKS) DET' 28 COY (E.L.)
CHIEF ENGINEERS OFFICE
OTHER R.E. OFFICES
PERSONNEL ALLOTTED

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PROFESSIONAL NOTE.

RAFT APPROACHES WITH LIGHT BRIDGE EQUIPMENT FOR FIELD SQUADRONS.

(Communicated by the R.E. Board.)

1. The following (" draw-bridge ") method has been tried for the raft approach with Light Bridge Equipment.

2. A Weldon Trestle and shore bay were erected and snatch blocks secured to the heads of the trestle legs.

The ends of two 3-in. cables, which passed through these blocks, were fastened to a transverse baulk which was lashed under a bay of superstructure connecting the Weldon trestle with a pontoon raft. This baulk was lashed to the five road baulks 2 ft. 6 in. from their outer ends. By pulling on the running end of the 3-in. ropes the " gangway " pivoting on the transom of the Weldon trestle could be lifted clear of the saddle of the pontoon raft.

A 9-in. lift was sufficient to do this.

3. The minimum height of the snatch block above the transom should be 6 ft. With this height and the raft on a level with the trestle transom, the pull on each running end was 700 lbs. (9 men)

When the raft was 2 ft. 6 in. below the trestle transom, the pull on each running end came to about 1,000 lbs. (13 men).

The number of men can be reduced by using tackles.

4. When trestles cannot be used or are not available the same method can be adopted by erecting 8-ft. posts with a strut and tie at each end of the shore transom.

5. By using cut baulks the operation can be simplified, provided the slope from the transom to the raft is not too great. The cut baulk saddle should be lightly lashed to the shore (or Weldon trestle) transom.

6. This drawbridge method appears to be much more easily worked than the method shown in *M.E.* Vol. III., p. 67.

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AN OUTLINE OF THE EGYPTIAN AND PALESTINE CAMPAIGNS, 1914—1918.

By MAJOR-GENERAL SIR M. G. E. BOWMAN-MANIFOLD, K.B.E., C.B., C.M.G., D.S.O., *p.s.c.*

(*Concluded*).

CHAPTER XIII.

THE MAIN ATTACK. THE BATTLE OF SHARON.—Preliminary advance by XXth Corps. Destruction of the Turkish telegraph centres early on 19th September—Operations of XXIst Corps: Attack by 60th and 75th Divisions—Start of the Cavalry—Wheel of XXIst Corps—Capture of Tulkeram—Advance of XXth Corps on 20th September—Five phases of the Operations.

THE MAIN ATTACK. THE BATTLE OF SHARON.

THE concentration was completed on 18th September. The main attack was ordered to commence at dawn on 19th September.

During the night 18th–19th September, in the XXth Corps area, the 53rd Division made its advance on the east of the Nablus road; and the Royal Air Force bombing squadron set out to attack Afule, Jenin, Nablus and Tulkeram, and particularly with the object of destroying the telegraphs at the headquarters of the lines of communication, and of the VIIth and VIIIth Turkish Armies.

The objectives for the XXIst Corps were as follows:—

First Objective.—Three Bushes Hill (north of Rafat) to the Nahr Falik. (See *Plate* XI.)

The infantry were to advance under a barrage, put down at the moment they were to move out from their places of deployment.

The French contingent to advance north of the Wadi Ballut.

The 54th Division to take ground north and west of Mejdel Yaba.

The 3rd, 75th and 7th Divisions to overrun the Tabsor defences.

The 60th to reach the Nahr Falik and form a bridgehead there.

The 5th Australian Light Horse Brigade were under the orders of the G.O.C. 60th Division, but took post to start with behind the 7th Indian Division.

The 4th and 5th Cavalry Divisions were placed behind the 75th and 60th Divisions respectively.

Immediately the first objective had been secured, the XXIst Corps had to wheel to the east, clear the Kalkilieh–Tulkeram road, seize the high ground east of the railway, and be ready to continue the advance on Jenin.

The cavalry were to set out on their great envelopment.

The French were to be the pivot for the wheel of the infantry.

The 54th Division had to move north-east into the hills by Hableh.

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The 3rd Division was to pass Kalkilieh and face east.

The 75th and the 7th Divisions were first to secure the Et Tireh defences, and then the 7th was to come up on the left of the 3rd.

The 60th Division, on the extreme left, with the 5th Light Horse Brigade, was to swing across the Plain of Sharon—half-right—occupy Tulkeram, and cut the railway east of that place.

At 0430 hours the artillery barrage in the coastal plain opened with an intense bombardment, lasting for 15 minutes, while the infantry moved out from their positions of deployment.

The attack of the XXIst Corps was supremely successful and according to plan. The speed of the infantry exceeded all expectations. A few details of the attack of the 75th and 60th Divisions will be of interest.

The 75th Division put two brigades in front and attacked in two waves. The leading wave of each brigade consisted of two companies of each of the two attacking battalions in depth. The second wave comprised the remaining two companies of each battalion, also in depth. Leading platoons of the first wave were extended, the remainder followed in artillery formation. The distance between the first and second waves was two hundred yards, and 500 yards from the second wave to the support battalion.

The 75th Division had, besides its divisional artillery, the support of four batteries of Royal Horse Artillery, six heavy howitzers, an armoured-car battery, and a squadron. The barrage had lifts at fixed times. No reliance was placed on the artillery for wire-cutting.

The 232nd and 234th Brigades advanced rapidly at first, and overran their part of the Tabsor defences, but the 232nd Brigade was checked at 0815 hours south-east of Et Tireh. The man-handled machine-guns had been outpaced, but got up in time to co-operate in the capture of the Et Tireh works which were taken by 1100 hours.

On the coast, the 60th Division advanced with the 180th Brigade Group leading. Its task was to cross the Nahr Falik, and form the bridgehead. Then, the 181st Brigade was to pass through 180th Brigade and with the 179th Brigade make Tulkeram in three more bounds of about five miles each.

The 5th Australian Light Horse Brigade were directed to keep away on the west, and come down on Tulkeram from the north.

The barrage had opened at 0430 hours. By 0500 hours in the 60th Division front the first line was taken.

By 0530 hours all the second line was occupied

At 0630 hours the 5th Cavalry Division were told they might send up two brigades along the beach, where they had a covered way to move by.

At 0700 hours, the bridgehead was established, and half an hour later the 5th Australian Light Horse Brigade were ordered forward.

No bridge was necessary for the cavalry to cross the Falik. The cavalry now were fairly launched.

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By 1100 hours, the wheel of the XXIst Corps had taken effect; the broken VIIIth Turkish Army was streaming across the plain towards Tulkeram—where chaos ensued. Horse and foot, artillery and transport of the VIIIth Army were striving to escape east, along the road which becomes a defile towards Messudie. Upon these the bombers of the Royal Air Force descended and returned again and again.

The road to Nablus became hopelessly blocked; and in the afternoon, when the 5th Australian Light Horse got on to that road, four miles east of Tulkeram, and the 60th Division reached that town, great booty was secured.

The XXth Corps now got orders to advance that night (19th–20th September) on Nablus; a difficult task, as the VIIth Turkish Army was not disorganized, and was holding a strongly-entrenched series of ridges across the main Nablus road.

The attack of the 10th Division was, therefore, delivered from the left flank, over broken roadless country so as to avoid a frontal advance. The 10th Division took Furkhah, Selfit, and Kefr Haris, and advanced about seven miles. The 53rd Division moved forward about two miles.

On 20th September, the XXIst Corps continued to advance eastward and, by the evening, the 5th Australian Light Horse Brigade and 60th Division had seized Messudie Station and the Jenin road; and, with the 7th Division on their right, had completely turned the right flank of the VIIth Turkish Army, and shut off their exit to the Jenin road.

Next day the 10th Division was just outside Nablus, having covered 24 miles of the roughest country within 24 hours, while the 53rd Division arrived six miles on the east of Nablus, after overcoming considerable opposition in the morning. The XXth Corps may be said to have secured Nablus on the 21st September. And this crowned the first phase of these operations.

Altogether there were five phases:—

(*a*) The first phase had been barely 36 hours. By 1700 hours on 20th September, the VIIIth Turkish Army had been overwhelmed; and the VIIth was in full retreat, through the hills of Samaria towards exits which were already held by the Desert Mounted Corps.

(*b*) In the second phase, of three days, the fruits of the first success were reaped. The infantry, pressing on the retreating enemy, drove him into the arms of the cavalry, with the result that the whole of the Turkish VIIth and VIIIth Armies were captured. Haifa, Acre, Tiberias, and the country south and west of the Sea of Galilee were occupied on 23rd September. On 22nd September, the IVth Turkish Army east of the Jordan began to retreat, and Maan was evacuated.

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(*c*) The third phase commenced with the pursuit of the IVth Turkish Army by Chaytor's Force and ended in the capture of Amman on 25th September, and the surrender of the intercepted garrison of Maan on 29th September.

(*d*) The fourth phase included the advance of the Desert Mounted Corps to Damascus (taken on the 1st October), the capture of the remnants of the IVth Turkish Army, and the advance of the XXIst Corps by the coast to Beirut by 8th October.

(*e*) The fifth phase was the advance through Syria to Homs and Tripoli, and the occupation of Aleppo on 26th October.

All these operations form one story which is continued in the next Chapter.

CHAPTER XIV.

THE BATTLE OF MEGIDDO: DESTRUCTION OF THE THREE TURKISH ARMIES.—Instructions issued to Desert Mounted Corps—The advance of the Cavalry: Moves of 4th and 5th Cavalry Divisions—Charge of the 2nd Lancers at El Lejjun—Capture of El Afule, Nazareth, Beisan and Jenin within 36 hours—Destruction of VIIth and VIIIth Turkish Armies—Capture of Amman; Destruction of IVth Turkish Army—Action of Sherif Feisal's Column.

THE BATTLE OF MEGIDDO—DESTRUCTION OF THE TURKISH ARMIES.

THE narrative in the previous Chapter showed how the infantry opened the way for the cavalry into the Plain of Sharon, and outlined the five phases into which the operations became divided. It now remains to follow the progress of the rest of the first stage. (See *Plates* XII and XIII.)

The full text of the instructions issued to the G O.C. Desert Mounted Corps is given in *Appendix* IV. Three features in these orders require emphasis :—

(*i*) The cavalry were on no account to get drawn into local fighting at the outset.

(*ii*) If any enemy retreated on Haifa, only the minimum detachment might be made to cover the lines of communication of our cavalry, so that the greatest possible force should be brought on for the task in hand, *viz.*, to seize El Afule and Beisan.

(*iii*) The action of the cavalry was to be characterized by the greatest vigour and rapidity.

The Advance of the Cavalry.—Before daylight on 19th September, the Desert Mounted Corps had assembled behind the 7th (Meerut) and 60th Divisions.

The leading divisions moved out through the gap created by the infantry, at 0900 hours by two routes, and by noon they were on the line Jelame–Hudeira, 18 miles away. The 5th Cavalry Division thence proceeded north for about ten miles, and, crossing the ridge of hills, entered the Plain of Esdraelon at Abu Shusheh, and then directed the 13th Brigade to raid Nazareth, and the 14th Brigade to seize El Afule.

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The 4th Cavalry Division turned north-east, entered the narrow Musmus Pass at 0100 hours, just in time to forestall its occupation by a Turkish battalion. The 2nd Lancers, moving from El Lejjun on El Afule, encountered this battalion, barring the road. One squadron, a machine-gun section, and L.A.M. Battery held the enemy in front, while the remainder of the regiment made a detour, and charged down on the left of the Turks. They speared 46 Turks, took 470 prisoners, and six machine-guns, and their casualties were one man wounded and three horses killed.

The leading troops of the 4th Cavalry Division reached El Afule at 0800 hours, half an hour after it had been occupied by the 5th Cavalry Division.

After a rest of four hours, the 4th Cavalry Division marched over the Valley of Jezreel and reached Beisan at 1630 hours, having covered 85 miles in 34 hours. The 19th Lancers, however, went 12 miles further that evening, to seize the bridges over the Jordan at Mejamie.

The 13th Brigade of 5th Cavalry Division, meanwhile, at 0530 hours, had entered Nazareth, headquarters of the Yilderim Army Group. Street fighting ensued; 2,000 prisoners, including some of the Headquarters Staff, were taken, and the office and records were captured. General Liman von Sanders himself escaped to Damascus. The 13th Cavalry Brigade then came in to El Afule.

The Australian Mounted Division (two brigades only) followed behind the 4th Cavalry Division to El Afule, but at Lejjun it detached a brigade which occupied Jenin at 1730 hours, and there took 8,000 prisoners.

Thus, within 36 hours, while the infantry had broken, and was following up the VIIIth and VIIth Turkish Armies, the cavalry had closed all their main roads of escape.

So ended the first phase of this campaign.

Destruction of the VIIth and VIIIth Turkish Armies.—On 21st September all organized resistance was at an end, the retreat had become a rout.

The 5th Australian Light Horse Brigade entered Nablus from the west, and the 10th Division from the south. By nightfall, the right of the XXth Corps was on the Wadi Fara, and the XXIst Corps were in Samaria.

All roads leading north and east were thronged with fleeing troops and transport and were targets for persistent bombing by the Royal Air Force. Those who got through alive merely walked into the net spread by the Desert Mounted Corps. In the Wadi Fara, leading from Nablus to Jisr ed Damie, the retreating column some eight miles long was caught in a gorge, and bombed to destruction. The drivers deserted their vehicles, and the road became indescribably blocked for miles.

The 4th Cavalry Division now was moving down the Jordan,

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closing the crossings below Beisan. Early on 22nd September, Jisr ed Damie was taken by a detachment from Chaytor's Force, and all escape towards Amman was cut off.

On 23rd September, the 5th Cavalry Division captured Haifa, after some resistance, while its 13th Brigade re-occupied Nazareth, and then took Acre.

Practically the whole of the VIIth and VIIIth Turkish Armies, horse, foot and artillery were now rounded up ; and it became a serious difficulty to water and feed the throngs of prisoners.

The Capture of Amman and Destruction of the IVth Turkish Army.— The destruction of the VIIth and VIIIth Armies, and the occupation of Jisr ed Damie, with the bridge intact, on the morning of 22nd September, compromised the position of the IVth Turkish Army. That night it withdrew from the Jordan Valley, and on 23rd September—four days after the blow fell on the coast—it was in full retreat on Es Salt and Amman, pursued by the Australian and New Zealand Mounted Division, and bombed by the Royal Air Force. On the same day Maan was evacuated and Es Salt was taken on 23rd and Amman on 25th September. The enemy retreated north, harassed by the Arabs, and leaving 5,000 prisoners in the hands of Chaytor's force.

Chaytor's force was now ordered to remain at Amman to intercept the Turkish IInd Corps, in retreat from the south, and pursued by the Arabs. On 28th September, the Corps had arrived within ten miles of Amman, and next day it surrendered, thankful to escape the attentions of the Arabs surrounding it.

Sherif Feisal's column continued at Um Taiye until 26th September, when it moved to Sheikh Saad, north-west of Deraa. Large accessions of Arabs had joined, so that it now numbered over 12,000. The Arabs captured almost all the guns and transport of the IVth Turkish Army, on the march near Er Remte, and greatly harassed the retreating enemy ; and on the 28th September they occupied Deraa.

CHAPTER XV.

THE ADVANCE ON DAMASCUS.—Desert Mounted Corps moved in two columns—4th Cavalry Division east of the Jordan, remainder at first on the west—Rearguard fighting at Jisr Benat Jakub and at Katana—Seizure of Barada Defile—Closing of the Aleppo road—Occupation of Damascus—Advance to the line Rayak–Beirut—Occupation of Northern Syria, Aleppo, and the Bagdad railway—Observations employment of cavalry in mass.

THE ADVANCE ON DAMASCUS.

THE total defeat of the VIIth and VIIIth Turkish Armies opened the way to Damascus. On 25th September, orders were issued to the Desert Mounted Corps to occupy the capital of Syria, and to intercept the retreat of the last of the IVth Turkish Army. (See *Plate* XIII.)

The headquarters of the Corps were then at Nazareth, the 4th Cavalry Division was about Beisan, the Australian Mounted Division on the Sea of Galilee, and 5th Cavalry Division at Haifa and Acre.

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The Corps advanced in two columns. The 4th Cavalry Division crossed the Jordan, and met with considerable opposition in the very broken country about Irbid and Er Remte. The first day's march was 38 miles. The approach to Er Remte was blocked by Turkish infantry; and so the Dorset Yeomanry were left dismounted to hold them in front, while the Central India Horse and 2nd Lancers worked round the flank. Meanwhile, the Turks launched a counter-attack on the Dorset Yeomanry. The latter withdrew rapidly behind the ridge they were holding, mounted and charged directly on to the advancing Turks. They killed twenty-five and dispersed the remainder. The Division joined up with the Arab force on 28th September about Mezerib and pressed up the Mezerib–Damascus road on the heels of the remnant of the IVth Turkish Army, with Sherif Feisal's force on its right, on the Deraa–Damascus road.

At the same time, the Australian Mounted Division, having assembled at Tiberias, marched on Damascus by the Kuneitra road, followed by the 5th Cavalry Division.

They met first with opposition at Jisr Benat Yakub. This ancient stone bridge was damaged, and the crossing was held by a German and Turkish rearguard sent down in lorries from Damascus. After some delay, on 27th September, the 5th Australian Light Horse Brigade forded the river lower down, outflanked the enemy and cleared the main road.

The divisions now had to climb up out of the Jordan valley, 3,500 feet in 16 miles, to the foothills of Mount Hermon; and for the first five miles the road was most difficult—boggy in places—and metalled with stones which Mr. Massey has described as varying in size from a man's head to a camel's body.

The villages in this locality—Circassian colonies—were hostile towards the British, and there was a good deal of sniping. Further fighting ensued at Kuneitra, and at Sasa, 20 miles from Damascus.

The Desert Mounted Corps and the Arabs now bore down on Damascus, on a broad front on three roads. At 1000 hours on 30th September, the 4th Cavalry Division and the Arab forces on their right, swollen to about 35,000 men, were near Kiswe; part of the 4th Cavalry Division were approaching Sahnayah, and the Australian Mounted Division were at Katana, checked by a strong rearguard.

About noon on 30th September, the rearguard at Katana was driven in, and the Australian Mounted Division worked round the west and north-west of the city. The 5th Australian Light Horse Brigade and French Cavalry seized the Barada defile of the Beirut road four miles out, and entrapped a great column of troops. Many Turks were slain, and 4,000 prisoners were taken. That evening the 5th Cavalry Division was in the southern surburb of Damascus. The 4th Cavalry Division bivouacked 15 miles south, having fought continuously and marched 140 miles in six days.

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Meanwhile, Damascus was in turmoil. Turks and Germans were literally fighting for vehicles, and no enemy administration remained to arrange any formal surrender of the city.

In the early hours of 1st October, the 10th Australian Light Horse and the Shereefian Camel Corps both were in the centre of the city; and, in the afternoon, part of the Desert Corps marched through the streets in a scene of the wildest enthusiasm.

During the morning, the Aleppo road on the north was finally closed, and the Turks along it were pursued for seventeen miles by the 3rd Australian Light Horse Brigade, and about 1,500 Turks were captured. For the next three days, stragglers and fugitives kept coming in. Altogether about 20,000 prisoners were taken in and round Damascus.

Out of all the three Turkish armies which, 12 days before, had numbered a ration strength of 104,000 men, some 17,000 men (of whom 4,000 only were effective rifles) dispersed north—a rabble, without artillery, transport or supplies.

The Advance to the Line Rayak–Beirut.—The Commander-in-Chief determined further to exploit the success by advancing to the line Rayak–Beirut. Beirut was a good port and harbour, and the railway and road over the Lebanon to Damascus would provide a much shorter line of supply. Besides, the Hedjaz railway had been so effectively damaged that it would require several weeks to restore traffic on it for our use.

Accordingly, the XXIst Corps was ordered on 29th September to move by the coast on Beirut; and on the 3rd October the 7th (Meerut) Division set out from Haifa and entered Beirut unopposed on 8th October. Meanwhile, on 6th October, the Desert Mounted Corps had occupied Rayak Junction without fighting, and captured immense depôts of stores at that place.

The Occupation of Northern Syria, Aleppo, and the Bagdad Railway.– Immediately Beirut had been entered, the Desert Mounted Corps and XXIst Corps were ordered to advance on Homs and Tripoli, respectively. The Australian Mounted Division was left at Damascus, pending relief by infantry. (See *Plate* I.)

The 7th (Meerut), followed later by the 54th Division, continued its march up the coast; the 5th Cavalry Division moved between the two Lebanon ranges, it met with no opposition, and reached Homs, 120 miles from Damascus on 15th October.

The roadstead of Tripoli, and a fair road across to Homs, rendered possible the supply of the mounted troops north of the Lebanon. In fact, it was only the simultaneous advance along the coast that enabled the force to be fed. The moves inland had been so fast, and had gone so far, that the troops outstripped the work of repairing the railway and the roads behind them. The Hedjaz railway had been extensively damaged by the Arabs, and the standard gauge

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railway north of Rayak was almost devoid of serviceable rolling-stock. Consequently, the bulk of the supplies had to go by motor-lorry, and the distances were immense, and much of the road atrocious.

Aleppo lay 120 miles north of Homs, and the enemy there was reported to number about 20,000, of whom about 8,000 were combatants demoralized. The Commander-in-Chief determined to press on. The 5th Cavalry Division advanced from Homs on 20th October. The weak rear-guards they encountered were dispersed by the advanced groups of armoured cars, until these were held up on 24th October, five miles south of Aleppo, by a strong line of resistance. The 15th (Imperial Service) Cavalry Brigade came up on the evening of 25th October; and that night a detachment from the Arab Army broke into Aleppo, and inflicted heavy casualties on the enemy.

Next morning, the 15th Brigade worked round the west of the city, and interposed itself on the Alexandretta–Katma road to prevent the Turks from re-entering Aleppo.

The 5th Cavalry Division occupied Muslimie Junction on the Bagdad railway on 26th October, but was too weak to proceed further to open up the way to Alexandretta, and the Australian Mounted Division from Damascus was ordered up in support; but, before it arrived, the Armistice with Turkey had been arranged, and on 1st November, Edmund Allenby's remarkable campaign officially terminated.

In twelve days, the enemy's armies had been routed and rounded up, and the front had been moved forward 160 miles.

Four weeks later the whole of Syria had been taken, the Bagdad railway had been cut, and touch was established with Mesopotamia. The front of the Egyptian Expeditionary Force was now 360 miles from its starting-point of six weeks earlier.

In this period the marches of the 5th Cavalry Division had totalled 500 miles, and it had expended 25 per cent. of its personnel, and 21 per cent. of its horses.

Comments.—The employment of cavalry in mass was the great feature of the operations conducted by Sir Edmund Allenby. At Beersheba, he first employed this arm on the open flank and rode right round the enemy. Twice later on he struck at distant objectives, Es Salt and Amman, and so impressed the Turks that they dreaded what he might do next, and kept their forces dispersed, and so caused their downfall. In the culminating operations, the Commander-in-Chief's plan was framed to enable him to use his cavalry mass so as to destroy the Turkish Army, instead of merely to complete a local success. And, having achieved his purpose, he used it to carry out—in spite of extraordinary difficulties—one of the most relentless pursuits in history.

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CHAPTER XVI.

REMARKS OF GENERAL LIMAN VON SANDERS.—Deficiencies of the Turkish Armies—Difficulties of the line across the Plain of Sharon—Effect of the loss of Jericho—Mussalabeh—Views on the Amman raids: Anxiety for Deraa—Three factors which impaired the Turkish resistance—The break-through, as seen by the enemy commander—Result of the destruction of the telegraph system—Plans for the retirement and protection of Damascus—Conclusion: errors committed by the Turks.

REMARKS OF GENERAL LIMAN VON SANDERS.

GENERAL LIMAN VON SANDERS has recently published his reminiscences, entitled *Fünf Jahre Türkei*, in which he depicts the events of 1918 from his point of view, and his views are worth examining. He makes the most of the stupendous difficulty of his problem, and particularly of his deficiencies in troops and supplies. If we were to believe his figures, he had in his three armies of ten divisions only 13,000 rifles and 1,200 sabres, and six weak German battalions. He gives the VIIIth Turkish Army only 3,900 rifles for their eighteen-mile front.

These figures are less than half those with which his opponents credited him; and the British captures (nearly 100,000 prisoners and 400 guns) tend to confirm their figures, rather than his.

General Liman von Sanders blames Enver for starving him in men, in order to invade the Caucasus in the summer of 1918, so that he was compelled always to act on the defensive, and he says he was so weak in transport that he could not move his troops to fresh positions.

Reviewing the actual position of the Turkish forces, when he took up the command in March, 1918, General Liman von Sanders' opinion is that the line adopted across the Plain of Sharon lacked natural strength. The only suitable line, he says, was the Carmel-Samaria range. But, to use that, the greater part of Palestine would have to be abandoned. This the higher command in Constantinople would not sanction. Besides, the loss of this territory would have given great impetus to the Arab movement.

He also objected to the retention of the Hedjaz railway (below Amman), but says Enver ordered this to be held.

General von Sanders' views on the course of the British operations confirm remarkably the correctness of the appreciations of their Commander-in-Chief. The loss of Jericho was a great worry to him. He wanted to reduce the fronts of his VIIth and VIIIth Armies, and explains that he could only have effected this, if he could have straightened the bulge the British has made north of the Wadi Auja.

This explains his employment of so many German troops to try and drive in the Desert Mounted Corps at Mussulabeh on 14th July, when, as he says, too, the Turks let the Germans down badly.

The first raid on Amman was considered to be a serious attempt to break through. The British surprise failed, but the German General tells us that the garrison of Amman on 30th March was on the point of surrender, and that he himself kept on urging the com-

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mander to hold out. So Amman affords yet another case of the last ounce turning the scale.

The second raid, on Es Salt, is admitted to have been a complete surprise. The flank march of the Australian Division is called "quite extraordinary"; and the track used by the 5th Mounted Brigade was unknown to the German Staff.

General von Sanders always had his eye on the Jordan valley. He noticed the presence of the British and the Overseas troops there in the hot weather, and comments bitterly on the order he received from Berlin to withdraw all German troops from the Jordan and place them in healthy stations. He replied that it was impossible to do so. He was obsessed with the conviction that the British Commander-in-Chief would try to cut across from the Jordan to Deraa, and refers to it again and again.

The raid of the 10th Division on 12th August is claimed as a victory for the Turks. Sir Philip Chetwode is credited with employing ten battalions in it. Actually, he used three. So this bears out that the General's figures must be taken with caution.

Coming to the preliminary events of September, three interesting facts are presented :—

(*i*) The great fire at Haidar Pasha Station in July deprived the Turkish armies of long-expected and sorely needed stores.

(*ii*) The Taurus tunnels were being converted to broad-gauge track, and this section of the Bagdad railway was closed during the last ten days of September—an inconvenient moment to choose.

(*iii*) The German Air Force was in a bad way. They were outclassed, and, when desperately short of machines, the replacements from Germany arrived seriously damaged; not once, but as a rule. This confirms the story in *Eastern Nights and Flights* of the passing British officer of the Royal Air Force who remonstrated with a prisoner working-party in the Taurus for working too hard in transhipping enemy stores, and found that, while the quantities they shifted seemed highly satisfactory to the Turks, the damage they were systematically effecting was equally satisfactory to themselves.

On 17th September, a deserting havildar is said to have reported that a great attack in the coastal sector was to open on the 19th. As a result of this information, apparently, the 46th Turkish Division was moved into the Et Tireh defences. But on the same day the news came in of the wrecking of the railway all round Deraa. General Liman von Sanders says he concluded that "major operations were beginning," and immediately ordered up the German battalion at Haifa to Deraa.

Thirty-six hours later the major operations did begin, indeed.

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But General von Sanders' introduction to them was that his line of communication centres were bombed, and he was cut off from news or control of what was going on.

He reverts to the failure of his communications frequently. He says that not only were the various headquarters heavily bombed but that, elsewhere, the Arabs broke down the permanent telegraph lines—a tribute to the efficiency of Colonel T. E. Lawrence's arrangements. Anyway, the German commander had only precarious and intermittent communication with the front, and scanty and inaccurate information.

About 0930 hours, he heard that some cavalry had penetrated by the coast and were going north. He considered that their objective was Haifa, and warned the Commandant there. The possibility of a total collapse on his right did not enter his head. He expected the VIIIth Turkish Army would fall back on successive positions, and display the usual stubbornness of the Turk on the defensive. During one of the moments of intermittent repair of the telephone, about 0930 hours, he ordered a counter-attack from Kalkilieh towards the coast, and was told this was already proceeding. Only, when the wire was again momentarily restored, about mid-day, did he first hear that the coastal front was lost, and the remnants of the VIIIth Army were falling back on Anebta. With the headquarters of the VIIIth Turkish Army he never had any communication at all.

General von Sanders then gave orders for Lejjun to be held, and sent a *Gendarmerie* regiment from Nazareth under a German officer to do it. The 2nd Lancers disposed of this force (page 355).

He was unable to draw on the VIIth Turkish Army for troops, because they were being attacked now. But, even in the afternoon, General von Sanders does not seem to have realized his desperate situation, and, lacking precise information, he hoped that his right was falling back systematically, fighting. He issued orders for the IVth Turkish Army to retire to the Zerka, the VIIth to Beisan, and remnants of the VIIIth to Jenin. Only some days later was the full extent of the rout known to the Yilderim Headquarters.

General von Sanders' own comment is that his front had been too dispersed and that behind it, for 200 kilometres, the country was devoid of troops, except Arabs and Labour Corps.

When Nazareth was raided on 20th September, it was not entirely surrounded. General Liman von Sanders reached Tiberias at 1530 hours, and there tried to organize resistance. His plan was to hold the line of the lakes, Hule and Tiberias, and the Yarmuk valley to Deraa, whither he went himself—by trolley, presumably—after ordering Yilderim Headquarters to re-open at Damascus. Semakh, which was the keystone of this position, was held by Germans, who put up a stout resistance when it was captured on 25th September.

It is interesting to note that the move of the Desert Mounted Corps across to Damascus was not what the Germans expected.

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According to General von Sanders, Sir Edmund Allenby's rôle should have been to stick to the coast, to land a force at Beirut, and to send mounted troops up the Litani valley direct to Rayak Junction. This looks very direct on the map, but the tracks were hopeless for a large force, whereas the Kuneitra road, bad though it was, proved passable for lorries.

The Rayak line, which the German General hoped to hold, was unsound. When the British had taken Damascus, they had a direct road to Homs behind him, and could cut his forces off. General von Sanders abandoned Rayak Junction on 2nd October, and retired to Aleppo. Then the Arab movement spread to Homs, Hama, and Aleppo, and the situation became hopeless in the north, too.

General von Sanders complains, with justice, that his government did not understand the situation and conditions in Palestine, and greatly over-estimated the military capacity of Turkey. It seems to have been no fault of his that he was out-numbered and ill-supplied, but it is also undisputable that on the field of battle he was out-generalled, misled, and out-manœuvred everywhere.

Conclusion.—The progress of the *Entente* Powers in the War is reflected in the campaigns of Egypt and Palestine. In 1914 and 1915, the British were on the defensive everywhere and the Turks had the initiative. During 1916, the tide began to turn. The defensive was abandoned, Sinai was retaken, and the initiative passed to the British while the Turks got into difficulties. In 1917, the Turks were staggered by defeats entailing the loss of Mesopotamia and half of Palestine. And when the knock-out blow fell in September, 1918, their collapse was complete.

Turkey was misled politically and strategically. She was the cat's-paw for Germany, and stood to gain little, as Germany meant to have a lot. The Turks were handicapped from the outset. They began war-weary; their difficulties were immense, no sea-power, inadequate communications, insufficient military resources: Gallipoli had ruined their army. It was a prime strategical error to attack Egypt at all; but, having done so and brought trouble on themselves, they aggravated that error by neglecting the menace from Egypt on Palestine.

Even after the Turks had lost Jerusalem, they continued to commit errors. For example, when the Russian revolution relieved them from pressure in the Caucasus, instead of coming away from that front, they indulged in a race for Baku with the Germans, and even tried to invade Persia.

Again, they would not cut their loss at Medina and Maan, but played the part mapped out for them by Colonel Lawrence, of expending their men and resources to no advantage.

They did contemplate withdrawal from Medina, but perhaps gave it up because they feared their troops would all be cut up in traversing the hostile Arab country. They might have abandoned

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Maan, but probably feared that their hold on Deraa would then be imperilled; and the latter place was vital to them so long as they remained in Central Palestine.

Their worst mistake was, perhaps, to credit Sir Edmund Allenby with the intention of operating directly against Deraa, by taking Amman. Fear of this induced them towards the end to keep nearly a third of their total force east of the Jordan, and in a country almost devoid of roads. But, as already pointed out, they had been encouraged in every possible way to believe in his intention to make a big move across the Jordan. It might be argued, that Sir Edmund Allenby later on did feed and maintain his cavalry corps over 100 miles from railhead, in spite of the abominable roads. And so he did, but he was able to do so, because he had first crushed the Turkish armies.

The great anxiety at our General Headquarters was lest the Turks, who knew the British intended to attack eventually, should fall back. No doubt, they would have been very promptly followed up, but such a course would have gained them some time. The British forces would have lost the advantage which their railways and roads, built close up to the front line, had given them, and also the surprise which was the essence of Sir Edmund Allenby's success would have been lacking.

The greatest feature of the operations which crushed the Turks was the achievement of the cavalry, and in this connection, the views of Field-Marshal Lord Allenby himself on *Cavalry in Future Wars** are of special interest :—

> "The truth is that cavalry can and will fit in its tactics to any country . . . " (and the Field-Marshal instances its use) "in . . . . the deserts east and west of Egypt, the rocky hills of Judea, the plains of the Palestine coast, the deep valley of the river Jordan, and the mountains of Moab."
>
> Then the Field Marshal continues :—
>
> "Experience teaches that a mounted attack, exactly timed, is almost always successful, and is less costly than a fire fight."

APPENDIX II.

Copy No.....

EXTRACTS FROM FORCE ORDER NO. 54, BY GENERAL SIR EDMUND ALLENBY, K.C.B.,

Commander-in-Chief, Egyptian Expeditionary Force.

Reference maps :— GENERAL HEADQUARTERS,
PALESTINE 1/20,000. *22nd October*, 1917.
PALESTINE 1/63,300.

1. (Intelligence will be issued periodically.)

2. It is the intention of the Commander-in-Chief to take the offensive against the enemy at Gaza and at Beersheba, and when Beersheba is in our hands, to make an enveloping attack on the enemy's left flank in the direction of Sheria and Hareira.

* A Foreword for the *U.S. Cavalry Journal*, January, 1921.

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3. (*a*) On Zero day the XXth Corps (with the 10th Division and Imperial Camel Brigade attached), and the Desert Mounted Corps (less one Mounted Division and the Imperial Camel Brigade) will attack the enemy at Beersheba with the object of gaining possession of that place by nightfall.

(*b*) As soon as Beersheba is in our hands, and the necessary arrangements have been made for the restoration of the Beersheba water supply, the XXth Corps and the Desert Mounted Corps will move rapidly forward to attack the left of the enemy's main position, with the object of driving him out of Sheria and Hareira and enveloping the left flank of his army. The XXth Corps will move against the enemy's defences south of Sheria, first of all against the " Kauwukah " line, and then against Sheria and the Hareira defences. The Desert Mounted Corps, calling up the division left in General Reserve during the Beersheba operation, will move north of the XXth Corps to gain possession of Nejile, and of any water supplies between that place and the right of the XXth Corps, and will be prepared to act vigorously against and round the enemy's left flank if he should throw it back to oppose the advance of the XXth Corps.

(*c*) On a date to be subsequently determined, and which will probably be after the occupation of Beersheba, and 24 to 48 hours before the attack of the XXth Corps on the Kauwukah line, the XXIst Corps will attack the south-western defences of Gaza with the object of capturing the enemy's front line system from Umbrella Hill to Sheikh-Hasan, both inclusive.

(*d*) The Royal Navy will co-operate with the XXIst Corps in the attack on Gaza, and in any subsequent operation that may be undertaken by the XXIst Corps.

4. (*a*) On Z–4 day the G.O.C. XXIst Corps will open a systematic bombardment of the Gaza defences, increasing in volume from Z–7 day to Z–4 day at least.

(*b*) (*c*) (Details of naval co-operation).

5. (*a*) The XXth Corps will move into position during the night Z–1—Zero, so as to attack the enemy at Beersheba on Zero day south of the Wadi Saba with two divisions, while covering his flank, and the construction of the railway east of Shellal with one division on the high ground overlooking Wadis El-Sufi and Hannafish. The objective of the XXth Corps will be the enemy's works west and south-west of Beersheba as far as the Khalasa–Beersheba road, inclusive.

(*b*) The Desert Mounted Corps will move on the night Z–1—Zero from the area of concentration about Khalasa and Asluj, so as to co-operate with the XXth Corps by attacking Beersheba with two divisions and one mounted brigade. The object of the Desert Mounted Corps will be the enemy's defences from the south-east to the north-east of Beersheba and the town of Beersheba itself.

6. The G.O.C. Desert Mounted Corps, will endeavour to turn the enemy's left with a view to breaking down his resistance at Beersheba as quickly as possible. With this in view, the main weight of his force will be directed against Beersheba from the east. As soon as the enemy's resistance shows signs of weakening, G.O.C., Desert Mounted Corps, will be prepared to act with the utmost vigour against his retreating troops, so as to prevent their escape, or, at least, to drive them well beyond the high ground immediately overlooking the town from the north. He will also be prepared to push troops rapidly into Beersheba, in order to protect from damage any wells and plant connected with the water supply not damaged by the enemy before Beersheba is entered.

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Special instructions will be issued to G.O.C. Desert Mounted Corps, and a copy of these instructions will be forwarded for information to G.O.C. XXth Corps.

7. The Yeomanry Mounted Division will pass from the command of G.O.C. XXth Corps, at 0500 on Zero day, and will come directly under General Headquarters as part of the General Reserve in the hands of the Commander-in-Chief.

8. When Beersheba has been taken, G.O.C. XXth Corps, will push forward covering troops to the high ground north of the town to protect it from any counter-movement on the part of the enemy. He will also immediately put in hand the restoration of the water supply in Beersheba. G.O.C. Desert Mounted Corps will be responsible for the protection of the town from the north-east. . . . . (Line of demarcation . . . . .)

9. As soon as possible after the taking of Beersheba, G.O.C., Desert Mounted Corps, will report to General Headquarters on the water supplies in the *wadis* west of Beersheba, and especially along the Wadi Saba and the Beersheba—Tel-el-Milah road . . . . A preliminary survey having been made, G.O.C. XXth Corps, will report by wire to General Headquarters on the condition of the wells and water supply generally in Beersheba, and on any water supplies found west and north-west of that place. He will telegraph an estimate as soon as it can be made, of the time required to place the Beersheba water supply in working order.

10. When the situation as regards the water at Beersheba has become clear, so that the movement of the XXth Corps and Desert Mounted Corps against the left flank of the enemy's main position can be arranged, G.O.C. XXIst Corps will be ordered to attack the enemy's defences south-west of Gaza, in time for this operation to be carried out prior to the attack of the XXth Corps on the Kauwukah line of works. The objective of the XXIst Corps will be the defences of Gaza from Umbrella Hill, inclusive, to the sea about Sheikh Hasan.

11. Artillery (ammunition supply and expenditure).

12. Aircraft.

13. Communications—(*a*) with Royal Navy ; (*b*) towards Beersheba.

14. Maps.

15. Liaison.

16. Medical (three Casualty Clearing Stations at Imara, and two at Deir-el-Belah. Former to be sited, but no tents to be erected until after sunset on Z–1 day).

17. Prisoners of War.

18. Issue of Official Time.

19. The date of Zero will be notified in due course.

20. General Headquarters will remain in its present position.

(Signed) L. G. BOLS, *Major-General.*
Chief of the General Staff, Egyptian Expeditionary Force.

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APPENDIX IV.

Secret and personal. *Copy No. 2.*

Z/96/16.

Instruction to General Officer Commanding Desert Mtd. Corps.
(*Reference Force Order No. 68, dated 9. 9. 18*).

1. The General Officer Commanding XXIst Corps, has been entrusted with the task of breaking down the enemy's resistance in the coastal

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plain and opening the way for your Corps to cross the Nahir Falik and the Khez Zerkiyeh Marsh. In view of the long marches which you have to make and the necessity of conserving your full strength to carry out the important rôle assigned to you in the enemy's rear, you must on no account allow your troops to be drawn into the infantry fight south of the Nahr Falik, nor, after the passage of this stream, to be diverted from your objective by the presence of hostile troops in the Tul Keram–Kulunsaweh–et-Tireh area, which will be dealt with by the XXIst Corps. The advance of your Corps from its positions of readiness will be regulated by the progress of the XXIst Corps, and you will be responsible for arranging that the line Khez Zerkyeh–Mouth of the Nahr Falik is crossed at the earliest possible moment. In your approach march care must be taken that there is no interference with the movement of units and formations of the XXIst Corps engaged in the attack. It is particularly important that the fire of the Corps Artillery should not be masked.

2. Should any portion of the enemy's force retreat in the direction of Haifa, you will detach only sufficient troops to keep touch with it and protect your line of communications, as it is vital that as large a proportion of your force as possible should be available to carry out the rôle assigned to you, which is to place your troops about El Afuleh and Beisan where the enemy's railway communications can be cut at their most vital point, and whence you will be in a position to strike his columns if they endeavour to escape in a northerly or north-easterly direction. The action of your troops must be characterized by the greatest vigour and rapidity, as it is essential that they should reach El Afuleh and Beisan before the enemy can withdraw his rolling-stock and material or assemble troops for the defence of the railway.

3. On arrival at El Lejjun you will detach a Brigade to block the roads and railways passing through Jenin and to gain touch with the Cavalry Brigade attached to the XXIst Corps, which will be directed on Jenin from the south if the situation permits.

4. From El Afuleh a detachment will be sent to seize the road and railway bridges over the Jordan at Jisr Mejamie, moving by the road through Nein, Endor and Sirin (1/250,000 map). The railway bridge should be prepared for demolition, but not destroyed so long as we are able to hold it.

5. Demolitions on the railway should be limited to such as can be easily repaired.

6. Please acknowledge.

(Signed) L. J. Bols, *Major-General,*
Chief of the General Staff, Egyptian Expeditionary Force.

G.H.Q., E.E.F.
9th September, 1918.

Copies to G.O.C. XXth Corps; G.O.C. XXIst Corps, for information.

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THE SUPPLY OF BULK STORES IN WAR.

To the Editor, R.E. JOURNAL.

SIR,

As one who was concerned, in a small way, with both the provision and consumption of engineer stores in France during the war, I should like to express my appreciation of Colonel Sewell's admirable article in the July issue of the *R.E. Journal*, and to make one or two brief comments.

In para. 16 the author touches on the local purchase of engineer stores in the theatre of war, and remarks that it is a " subject which requires some control." I think that the facts would justify a stronger emphasis on the squandering of public money which actually took place and which always will take place if C.E.'s and C.R.E.'s are given a free hand in the matter. At the time of which he speaks (1915), I am afraid that I myself was among the " spenders " and joined merrily in the fierce competition with neighbouring Divisions; but what is a poor C.R.E. to do when confronted with the dilemma of either delivering the goods or being scrapped?

The root of the evil lies in the human tendency of the Higher Command, under the strain and stress of war, to judge solely by results achieved, without regard to attendant circumstances; a tendency which is apt to result in more or less unscrupulous competition between formations, from Armies down to Platoons, for the wherewithal to make a splash, and which led to such incredible absurdities as the removal, at a vast cost of labour and transport, of their respective outfits of workshops, laundries, theatres, etc., on the part of two Corps changing places in the line.

In para. 50 the author discreetly refers to another thorn in the flesh of the long-suffering C.R.E., who not infrequently found himself between the devil of the G.S. and the deep sea, as personified by the C.E. (the pun is unintentional but rather a good one). The former would demand that certain work should be carried out, and the C.E. would firmly refuse to supply the necessary stores, either on the flimsy excuse that he had not got them or that it was a silly game to play at and he was not going to encourage it.

Such a situation is always possible as long as the principle is accepted that a formation is responsible for the defence of the sector which it occupies, and the supply of engineer stores for that purpose is controlled by an independent authority. The Higher Command has, as a rule, a somewhat imperfect appreciation of the importance of the R.E. trinity, " Stores, Labour, Transport," in the execution of field defences.

The remedy lies, at any rate in position warfare, in the curtailment of the powers of Divisional and Brigade Commanders to initiate ambitious works of defence.

Yours, etc.,

Hong Kong. 21. 9. 22. C. W. DAVY, *Colonel.*

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THE EMPLOYMENT OF DIVISIONAL ENGINEERS IN CONJUNCTION WITH OTHER ARMS IN WAR.

Part of a Lecture delivered at the S.M.E., Chatham, on 10th July, 1922, to the Senior Officers' Class (all arms) by Brevet Major G. E. H. SIM, D.S.O., M.C., *p.s.c.*, R.E., Brigade Major, S.M.E.

1.—NECESSITY FOR A CLEAR DOCTRINE OF ENGINEER EMPLOYMENT.

Engineers exist solely to help the other arms to function. It is, therefore, most desirable that there should be some well-defined policy, doctrine, normal practice (call it what you will) governing the employment of engineers in conjunction with the other arms in war.

A lot of people are apt to jib at the word " Doctrine," but I think it is because they confuse it with the word " Dogma." A dogma is something we are asked to believe blindly without proof. A doctrine is something to be taught: evolved from accepted principles, logically deduced, based on experience and susceptible to variation in accordance with varying conditions.

The doctrine of engineer employment and the principles upon which it is based should be well known and understood, not only by the engineers themselves, but also by the commanders, staffs and troops of all arms. It is only where such understanding exists that the engineers of a force can be used to the best advantage.

The " Doctrine " crystallizes out into a " Normal Practice." Just as there is a normal practice for the supply of troops with rations and ammunition in the field, so must there be a normal practice for the employment of engineers, which everybody understands. The practice can, of course, be varied in abnormal circumstances, but it is advisable to stick to it, unless there is good and sufficient reason for departing from it. It will usually give the best results.

It is this " doctrine " or " normal practice " of engineer employment which we aim to put before you in this Course. You will find it clearly set out in Chapters VII. and VIII. of the new *Engineer Training*, 1922. Its detailed application to various operations of war will be dealt with subsequently in lectures and schemes during the course. This evening I want to explain the doctrine generally and the principles on which it rests, and, if possible, to enlist you as its champions.

2.—PRINCIPLES ON WHICH THE DOCTRINE IS BASED.

First let us see what are the principles on which any doctrine of engineer employment must be based. They are very few and very simple. They can, in fact, be boiled down to four. They are :—

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(i) *Economy of Force.*
(ii) *Avoidance of Divided Control.*
(iii) *Continuity in the Execution of Works.*
(iv) *Conformity of Work to the Tactical Situation.*

There is nothing new or controversial about these four principles. A moment's thought will enable you to see that unless they are observed the work is bound to suffer. It is the application of them which presents so many practical difficulties, and attempts to dodge the difficulties by departing from the principles led to an enormous waste of engineer effort during the late war.

3.—Lack of a Doctrine before the War.

Before the war nothing was laid down anywhere as to how engineers ought normally to be employed tactically, except the somewhat nebulous doctrine that every main body of troops should have its complement of engineers, which was to assist the infantry (in particular) in every possible way. This was much too vague to be of any use. Some commanders and engineer officers had given little or no thought to the subject. Those who had thought about it evolved theories of their own, some of them sound, some the reverse of sound, and all different.

4.—Violation of the Four Principles and its Results.

During the early part of the war, therefore, this absence of an accepted doctrine led to various methods being employed by individual commanders, with the result that in most divisions, one might almost go so far as to say in all at that time, each of the four principles was violated almost daily.

Economy of force was conspicuous by its absence. The skilled engineers were frittered away on work, such as wiring the front line, which the other arms ought to have done for themselves.

Divided control was rampant. The engineers were usually serving several masters, who gave contradictory orders as to the work to be done.

Continuity in the execution of works suffered because there was no settled policy and in many cases the newcomer scrapped the unfinished work of his predecessor.

Work, in many cases, did not conform to the tactical situation because it was nobody's business to see that it did.

5.—Evolution of Two Schools of Thought.

As the war progressed, however, bitter experience led to the evolution of doctrines of engineer employment. I say "doctrines," in the plural, advisedly, because there were two of them, and they both obtained right up to the end of the war and both have their adherents and advocates still. To these two schools of thought I

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shall refer in future, for shortness, as the "Brigade Group School" and the "Divisional Control School."

(i) *The Brigade Group School.*—One school held that the way to get the best value out of divisional engineers was to attach a field company permanently to each infantry brigade of the division, to work under the orders of the brigade commander at all times. This resulted in the C.R.E. becoming in practice merely an adviser to the G.O.C. Division on questions of engineer policy and having no direct responsibility for the execution of engineer work. Having allocated all his engineers to brigades, he had none with which to carry out work not normally coming within the jurisdiction of a brigade commander unless he could persuade a brigade commander to lend him some.

(ii) *The Divisional Control School.*—The other school held that the best way was to concentrate the responsibility for all engineer work of the division in the hands of the C.R.E. and that he should normally have the field companies under his own hand to allot as he, under the general staff of the division, thought best for its execution.

It is this second system, namely, the concentration of the whole engineer problem in the hands of the C.R.E., that has now been officially adopted in our Army and on which the doctrine taught in *Engineer Training* is based.

6.—Comparison between the Two Systems in the Light of the Four Principles.

If we examine the two systems outlined above in the light of the four principles of engineer employment already enunciated, we will, I think, find that the Divisional Control System wins every time. Let us take each principle in turn and see which of the two systems is likely to give us the best results.

(i) *Economy of Force.*—There is always in war more engineer work to do than there are engineers to do it. But some is more urgent and important than the rest. It may be vitally urgent to concentrate all the engineer resources of the division on some particular work in one of the brigade areas, leaving the other brigades for the time being to fend for themselves At another time it may be necessary to concentrate on work in which the brigades, at the moment, have little or no direct interest, such as rearward positions, artillery observation posts, burying cable for the signal corps, horse-watering points, preparations for demolitions far in rear in the event of a retreat, construction of roads, bridges, railways, inundations, hutted camps, etc. It is very difficult to arrange for this if every brigade has a vested interest in a field company and feels aggrieved if it is taken away, as it will if it is used to the Brigade Group System. The only person who can arrange that the engineer

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resources of the division are used economically (*i.e.*, used to the best advantage on the most important work at the most important place at the right time) is the C.R.E., after he has received his instructions from the general staff of the division. To enable him to put his plans into effect he must have his field companies at his disposal all the time.

It may at first sight appear that this " Economy of Force " will benefit the engineers at the expense of the infantry. Where the Divisional Control System was worked, however, infantry units soon came to take a great pride in doing without engineer assistance wherever possible, and they soon realized that it was to their advantage to set free the engineers for the work they could not do for themselves, but of which they reaped the benefit, either directly or indirectly, in the long run.

(ii) *Avoidance of Divided Control.*—This is a counsel of perfection in any case, and is usually unattainable in the case of the engineers. An engineer officer may consider himself lucky if he has to serve only two masters. This does not mean that he likes serving two masters. He gets used to it after a bit and puts up with it, but he does not like it. Under the Brigade Group System the field company commander always had two masters, the C.R.E. and the brigade commander, who often pulled opposite ways. When things were humming, the system could not be got to work at all unless all three, the two masters and the servant, were most tactful and reasonable beings. Any system which depends for its success on the tact and reasonableness of the individuals who have to work it must be radically unsound and liable to break down under stress. Take, for example, the case of a field company handed over to a brigade for an operation. The brigade commander makes his plan, which includes certain jobs for his field company. Everything goes swimmingly till the C.R.E. comes along and tells the field company commander that the division has ordered certain other work to be done at once and that he is to take half his company and get on with it. Not to do so will call down the righteous wrath of the divisional commander. To do so will seriously inconvenience the operations of the brigade commander who is relying on having the whole field company for his own jobs and has made his plans accordingly. It may mean that some bridge that he is relying on to get his ammunition up at night will not get built in time. The result is generally a compromise. Neither job gets done properly and everybody is peevish about it. That is an example of divided control which occurred times without number during the war where the Brigade Group System of engineer employment was in vogue. Under the Divisional Control System this difficulty is avoided as far as practicable. The C.R.E. has the whole of the engineer problem of the operation in his hands. The general staff decide what engineer

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works are necessary (among which, no doubt, will be the brigade commander's tactical bridge) and the C.R.E. details off his engineer companies to the various jobs, keeping an engineer reserve in his hands for eventualities. If it is desirable to do so he may allot a field company, or part of one, to a particular brigade for a specific job of work which, owing to the technical nature of the job, the Brigade cannot do for itself, but which must, for tactical reasons, be carried out under the direct orders of the brigade commander. In this case the C.R.E. knows that those sappers are out of his hands for the time being and that he cannot count on using them for work for which he is responsible. Under this system everybody knows where he is and the brigade commander knows what, if any, sappers he can count on. Everybody is happy and, what is much more important, the really necessary jobs of engineer work have a fair chance of getting done.

(iii) *Continuity in the Execution of Works.*—All engineer work takes time, sometimes an almost unbelievably long time, to do. Provision must, therefore, be made to ensure that, when brigades change and move on, the engineer work is continued on some settled line of policy. As a rule an engineering job is more or less useless until it is finished. Take a bridge, for example. It may take days or weeks to build but it is quite useless until the last plank of the roadway is laid and the first vehicle can cross. Unless the work is continued until that last plank is in position, all the work that has gone before is wasted and has done no good to anybody. The same is, to a greater or less degree, true of all engineer work. The best people to finish a job are usually in the unit that started it. When brigades are relieved or move on, the engineers must stay and finish their jobs. Under the Brigade Group System the field company moves with its brigade and leaves its jobs unfinished and therefore useless. The new brigade that comes along may continue them, but often the new brigade commander is impatient to get on with some pet scheme of his own and the old jobs get left. Then he, in turn, moves on, leaving the jobs his field company started also unfinished. In this way a theatre of war becomes littered with unfinished engineer jobs which represent millions of man-hours of absolutely wasted labour. Under the Divisional Control System the C.R.E. allots the jobs and is responsible for seeing that they get finished. He is in a position to do so, for divisions do not change nearly so frequently as brigades.

(iv) *Conformity of Work to the Tactical Situation.*—The division has a much more comprehensive view of the engineer requirements of the tactical situation than any brigade can possibly have. The C.R.E., who is in close touch with the G.O.C. and takes his orders direct from the G.S.O.1., is the best authority to advise as to what work is to be done, where, how, by whom, and in what order of priority. This is especially the case in rapidly moving warfare,

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though at first sight this would not appear to be so. Some say, "Leave the decision to the man on the spot, and the man on the spot is the brigadier." But is he? Undoubtedly the brigade commander is the "man on the spot" so far as fighting the battle is concerned, but is he as regards the engineer requirements of the situation? Surely he is not. The vital spot for engineer work may be, and probably is, right outside the purview of any brigade commander and can be located only by the man who can see the trend of the operation as a whole. That man in a division is not any one of the brigade commanders, but the divisional commander himself—and the C.R.E. is his prophet. In order that the C.R.E. may be able to put into effect the wishes of his divisional commander, he must have the field companies of the division at his disposal. Again, during a battle, the tactical situation is constantly changing, and with it the engineer requirements. Elasticity of the engineer resources and their adaptability to the changes of the situation are therefore essential. This elasticity and adaptability cannot be attained if the engineer units are rigidly attached to brigades.

7.—Liaison and Administration.

There are, however, two respects in which the Brigade Group System would appear at first sight to have the advantage over the Divisional System. These are Liaison and Administration. The permanent allocation of field companies to brigades renders liaison and personal knowledge between the engineer officers and the officers of other arms with whom and for whom they work much more easy of attainment. In the same way all administrative problems, such as supplies, billets, etc., are much more easily solved if the field companies are firmly attached to Brigades. But these advantages can be enjoyed to an almost equal extent under the Divisional System if it is properly worked, as I hope to show you later, and in any case both liaison and administration are only means to an end, not ends in themselves. The "end" is to get the right engineer work done as expeditiously, economically and effectively as possible.

8.—Description of the Normal Practice under Divisional Control.

I have gone into the arguments for and against each of the two systems at some length, because the whole accepted doctrine of engineer employment in conjunction with other arms is based on the assumption that the Divisional System is the normal practice. As the new *Engineer Training* is the first and only book that I know of that has ever attempted to teach a doctrine of Engineer Employment, it is as well to have a clear idea of the reasons which led to the adoption of that doctrine before proceeding to study the details of its application.

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The normal practice of engineer employment in a division is, therefore, this :—

(i) The control of the whole engineer problem of the division is concentrated in the hands of the C.R.E., working under the direction of the general staff of the division. He assists the staff in the drawing up of a programme of work to be done, allocates the work to the engineer units of the division, receives their progress reports and generally takes charge.

(ii) Brigades and other formations requiring jobs to be done for them by the engineers indent on the division for the execution of the job, not for a company or part of a company of engineers. It is then for the division to decide what, if any, engineers can be spared for the execution of the job and its order of priority in the general scheme, having regard to its urgency in comparison with the other jobs on the waiting list of the programme.

(iii) Engineer units will normally not be allotted to infantry brigades or other formations except for the execution of some specific job or operation which, for some reason, can better be done under the supervision of the brigade or other commander than it can under the C.R.E.

(iv) The abnormal practice of attaching engineer units to formations should be resorted to only when the formation is detached from the division on an independent mission. In such cases the engineer units so attached would be directly under the command of the commander of the formation and would cease to be available for work for which the C.R.E. is responsible. The normal practice should be reverted to as soon as the formation rejoins the division.

(v) To facilitate administration (supplies, billeting, etc.) it is usual to attach field companies to brigades for administration. It is desirable that this attachment be changed as infrequently as possible, but administrative considerations must never be allowed to outweigh the tactical which, in the case of the engineers, is the rapid and economical execution of the most important jobs of engineer work.

9.—Need for Good Liaison and Good Communications.

In order that the Divisional System of Engineer Employment may be efficiently worked, it is essential, not only that the C.R.E. be in the closest possible touch with the divisional staff so that he may know what is going on and what is required, but he must also be able to get intelligent reports on engineer matters from all the

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formations of the division, especially the infantry brigades, sift them quickly and, having made up his mind what ought to be done, convey his orders to the engineer units under his command. This is especially necessary in moving warfare.

To provide for this, two things are necessary and must be arranged for :—

(i) An efficient system of liaison between the C.R.E. and the infantry and other formations of the division.

(ii) An efficient and independent system of engineer communications.

10.—How Liaison is Provided for.

The reasons for and the method of carrying out engineer liaison are described in some detail in para. 59 of *Engineer Training*, and are so important that I recommend their careful study. The idea is that each brigade commander should have attached permanently to his staff an engineer officer for liaison purposes. His duties and functions are described fully in *Engineer Training*. Here are some extracts :—

" The main objects to be attained by such liaison are :—

" (i) To furnish the formations in immediate contact with the enemy with :—

" (*a*) A channel of communication respecting works between the commanders of such formations and the engineer commanders furnishing them with engineer assistance.

" (*b*) Technical information and advice respecting works for which the formations are responsible."

" (ii) To furnish engineer commanders with :—

" (*a*) A means for obtaining under all circumstances immediate and accurate technical information respecting the engineer assistance required by commanders of formations, and of forming a close and personal link between the engineers and the formations.

" (*b*) An agency for effecting all purely local preparatory measures necessary to ensure the rapid execution of works required of the engineers.

" (*c*) An effective agency for the organization and execution of engineer reconnaissances.

" The duties of the engineer liaison officer include the following, in addition to those specified above :—

" (*a*) To foresee and suggest to the staff of the formation to which he is attached the nature and occasions of the demands for engineer assistance.

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" (*b*) To take all measures necessary and practicable to facilitate the rapid execution of any work for which engineer assistance is furnished.

" (*c*) Executive work if required in special circumstances in connection with the carrying out of works for whose execution engineer assistance is forthcoming."

Such a liaison officer can be an extraordinarily useful person at all times, but in moving warfare or when things are really humming the Divisional System of engineer employment cannot work efficiently unless one is provided, at least, with every infantry brigade headquarters. If possible, therefore, a liaison officer should be provided at all times with each infantry brigade. They may also be provided for other formations, such as divisional artillery, tanks, etc., as and when occasion demands.

11.—How Communications are Provided For.

It is also essential that the C.R.E. be able to communicate quickly and directly with the engineer companies under his command. The divisional signals cannot adequately supply this need. During a battle their resources are stretched to the utmost to deal with operations messages, and engineer messages get held up. Also the nature of engineer work often necessitates the field companies working, and even living, at a considerable distance from any signal office on the divisional signal system. To obviate this difficulty, there must be a small number of motor-cyclist orderlies at the C.R.E.'s headquarters, independent of divisional signals altogether, for conveying his orders direct. For the same reason field companies must have their own motor-cyclist orderlies.

12.—How the System Worked during the War.

That is the system that has now been officially adopted in our Army. It was tried in many divisions during the latter part of the war and, in spite of circumstances which rendered its execution difficult, such as shortage of engineer officers for liaison purposes and the difficulty of improvising an engineer communication system, it was found to give excellent results during the 1918 retreat and in the advance afterwards in those divisions where it was adopted.

13.—Comparison with the Artillery System.

If we compare it with the system adopted for the employment of divisional artillery, we shall find that the two are practically identical.

The whole artillery problem of the division is concentrated in the hands of the C.R.A., who issues his orders to his artillery brigades in accordance with the needs of the division as a whole.

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Artillery brigades and batteries are not normally put under the command of infantry brigade commanders, unless it be for some specific operation, or when a brigade is detached from the division on an independent mission. They return to the fold of the C.R.A. as soon as the mission or operation is completed.

Infantry brigades ask the division for artillery support for a certain operation and the C.R.A. decides the nature and amount of support to be given.

A great deal of the work of the artillery does not come within the purview of the infantry brigade commander at all and must be arranged for divisionally.

The artillery have their own system of communications, the artillery brigade sections of the divisional signal company.

They also make extensive use of liaison officers with infantry brigades, whose duties are on all fours with those of the engineer liaison officers described above.

In fact, the problem of the employment of divisional artillery in modern war has been solved by the adoption of the system o Divisional Control. The engineer problem is capable of solution in the same manner.

14.—COMPARISON WITH THE FRENCH SYSTEM.

As a nation we are very apt to run ourselves down and to think that foreigners do things on a much better system than ours. It is, therefore, consoling to note that the French think precisely as we do on this subject of engineer employment.

I have here the translation of the notes of a lecture delivered at the French Staff College in March, 1918. The organization of the engineers in a French division differs slightly from ours in that they have two field companies instead of our three, but their teaching as to the duties of the C.R.E. and the employment of divisional engineers generally might have been written in close collaboration with the author of Chapters VII. and VIII. of our *Engineer Training*. As a matter of fact, the chapters in our manual were written without the knowledge of the existence of this pamphlet. I will conclude by reading you a few extracts from the French lecture which confirm our doctrine in a very remarkable manner :—

" (*a*) *Duties of the C.R.E. of a Division.*

" C.R.E.'s are alike technical advisers to their respective commanders and executive officers.

" As technical adviser the C.R.E. keeps his general posted as to :—

" (i) The requirements in time, labour and material of any proposed work.

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" (ii) The method in which works are being carried out by subordinate formations.

" As executive officer,

" (i) He collaborates in the preparation of programmes of work (in particular of that part in which the engineers are to take a hand) ;

" (ii) He is responsible for the completion of work entrusted to him by the commander and carried out by the engineer units.

" The programme of work for engineer units is always drawn up by the commander.

" Decisions with regard to important works are not the province of the C.R.E."

" The C.R.E. cannot carry out his duties efficiently unless he is always familiar with his general's thoughts, and never ceases to work in close touch with the staff. He must likewise keep in close touch with the commanders and staffs of subordinate formations, help them with his technical knowledge, keep abreast of their needs, foresee them if possible, and concentrate all his resources on satisfying them.

" (*b*) *Employment of Engineers.*

" The normal work of field fortification, construction and repair of trenches, barbed wire entanglements, etc., must be carried out by the infantryman. These tasks call for a large amount of labour, and engineer companies will only furnish an insignificant amount of supervising detail in any case.

" Engineers will, therefore, only be employed on tasks demanding skill greater than that possessed by the infantryman.

" (*c*) *Distribution of the Engineers.*

" Engineers, like infantry, work in properly constituted units, if possible, in companies ; it will only be in exceptional circumstances that they are employed by less than sections. A sapper only works well and gives full value when his organization is intact.

" An engineer unit, when engaged, must, like any other force, be given an objective. Hence, the attachment of parties of engineers to assaulting troops, without any definite reason, but as a matter of course, will be avoided.

" Engineers will only be attached to such regiments or battalions whose objectives involve types of work which justify the employment of technical troops.

" So we have established the principle that engineers are to be employed by whole companies, or, at least, by organized fractions, and that they are to be employed where their special skill will be of advantage. *It follows that they will not be permanently allotted to subordinate formations.*"

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*THE MATHEMATICAL CONCEPTION OF THE UNIVERSE.**

By COLONEL A. M. MANTELL (late R.E.).

IT is somewhat presumptuous of me to undertake to write a paper on the "Mathematical Conception of the Universe," as I must begin by confessing that there are many points which I cannot grasp even in the less advanced literature of the subject. As regards the more abstruse writings of authorities like Einstein, Whitehead and Weyl, there are probably only a few dozen people in the world who can follow them to the last word. However, as I have devoted a good deal of time to the subject, there is a possibility that some of my remarks may be of use or of interest to those who have not paid so much attention to it.

Mathematics in General.—It seems well to begin by reminding you that mathematics may be regarded as a sort of game like chess. Certain axioms are assumed—such, for instance, as the axiom that two straight lines cannot enclose a space. These axioms correspond to the chess-men. We deal with these axioms in accordance with certain logical processes which correspond to the "laws of chess," and we arrive at certain theorems which may be said to correspond to the result of the game of chess.

The supreme interest of mathematics lies in the fact that these theorems correspond, not only to the result of the game of chess, but also to the observed sequence of events in nature, *i.e.*, they give us what are called the "laws of nature."

Einstein and his co-workers have modified the axioms and carried mathematical processes further than their predecessors, and have thus arrived at theorems or theories which correspond more closely to the laws of nature than the theories of Newton and other earlier scientists.

I hope to be able to indicate roughly some of the points in regard to which these modern theories differ from the earlier or so-called classical theories of mechanics.

Mathematical Methods.—Mathematical methods may be divided broadly into two great classes :—

1. Purely geometrical methods, such as those used by Euclid.
2. Analytical methods, in which equations and formulæ are used as, for instance, in algebra and trigonometry.

* A paper read before a local Scientific Society.

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In analytical geometry the position of each mathematical point dealt with is fixed by means of certain measurements called co-ordinates. Thus, for instance, the position of the corner of a table in a room might be fixed by stating its distance from two walls of the room and its height above the floor. Other kinds of co-ordinates are used for special purposes, and during the last hundred years or so mathematicians have found it convenient and, in fact, essential, sometimes to use curved co-ordinates (the so-called " Gaussian " co-ordinates).

In using mathematical phrases to describe physical phenomena it is sometimes better to use the language of pure geometry, and sometimes that of analytical geometry, but both modes of expression have, of course, the same essential meaning.

During the last twenty or thirty years it has been more clearly recognized that there is one very weak feature in all this analytical geometry, *viz.*, that we do not know of any fixed point or body from which co-ordinates or distances may be measured. For most purposes the earth may be considered to be fixed ; for some purposes the sun may be taken as fixed ; but for certain cosmic questions in which the ether is involved, it is not possible to measure any co-ordinates whatever, and the most that can be done is to deduce equations—called " differential equations "—which give the relationship between the differences of the hypothetical co-ordinates.

To take a simple illustration, suppose a bottle is dropped from a window in a train : the person who drops it will see it fall in a straight line relatively to the train, while an observer outside the train will see it move in a curve (a parabola) relatively to the earth. No one knows what its absolute movement is ; nor, indeed, can we be certain that it is moving at all, but modern mathematicians have succeeded in finding differential equations which represent with extreme accuracy the movement of such an object as the bottle in question, and of all other objects which are dealt with in physical science.

Space and Time.—If we endeavour to describe the movement of the bottle, we naturally do so by saying that it travels through a certain space in a certain time. This raises another profound difficulty.

In the classical mechanics it was assumed :—

1. That we had available rigid foot-rules, etc., for measuring a uniform entity, called space, and
2. that phenomena, such as the rotation of the earth or the vibration of an atom, gave an invariable measure of a uniformly flowing entity called time.

But it is now recognized that we do not know of any such uniform entities as space and time existing on their own account.

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What we call space is really the expression of certain properties of matter, and for all we know a foot-rule may change its length entirely when it is carried from one side of a room to another, or when it is turned round. In fact, it is possible that all spatial dimensions are a hundred times greater or smaller to-day than they were yesterday.

Similarly as regards time: it is possible that the earth is rotating and the atom vibrating a hundred times faster or slower to-day than yesterday.

Practical Importance of the Above Considerations.—The above doubts as to the nature of space and time were familiar to philosophers long before Einstein began his researches. They were, in fact, involved in the paradoxes propounded by Zeno in the fifth century B.C. But they were not at first of practical importance, because the conclusions deduced by the methods of classical mechanics seemed to agree in all cases with the results of observation and experiment. During the last hundred years, however, the methods of measurement used by physicists have become far more refined, and have brought to light certain minute but perfectly definite discrepancies between theories and practice, and therefore (quite apart from philosophical considerations) it has been necessary to revise the theories.

The way in which this may come about may be illustrated as follows:—

Imagine a sphere of the size of the earth covered with a thin film of water, and imagine that there is a community of highly intellectual microbes living in the water, who are able to move about in the water, but who cannot leave it. These microbes would be living in a spherical space of two dimensions, and would have no conception of a third dimension. Imagine, further, that they are confined to a small area—say, within a mile or two of the north pole. They would naturally think that their space was flat—or, to use the correct technical term, "homaloidal."

If, then, they described a number of circles anywhere within the mile or two available for their observations, they would discover by measurement that the circumference of a circle was always equal to the diameter multiplied by π, or say $3\frac{1}{7}$, and this would confirm practically the conclusion which we may suppose them to have reached by mathematical reasoning.

If, however, the microbes were to improve their methods of measurement sufficiently, they would find that the circumference was not, after all, quite as great as π times the diameter, and that the larger the circle the more the circumference would fall short of this theoretical amount.

In this way they might arrive at the conclusion that the space in which they lived was not flat or homaloidal, and they might even

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be able to conceive of a third dimension, to discover that they were probably living on the surface of a sphere, and to measure approximately the size of the sphere.

Human beings are now in a similar position. The most accurate modern measurements have led to the conclusion that our three-dimensional space is not homaloidal, and that there is something which must be called a fourth dimension. The shape of this four-dimensional space is still under discussion, but it has been found possible to make a rough estimate of its size. It has been calculated that a ray of light travelling with its usual velocity of 186,000 miles per second would take about a thousand million years to travel round it.

Discrepancies between Classical Theories and Modern Measurements.—The modern measurements which led to these startling conclusions were obtained :—

1. In electro-dynamical and optical experiments, by Fizeau, Clerk-Maxwell and Lorentz during last century.
2. In regard to the velocity of light, by Michelson and Morley in 1887.

These experiments have not only led to the conclusion that our three-dimensional space is curved—*i.e.*, non-homaloidal—but, as mentioned above, have revolutionized our ideas as to space and time, and shown that they are not absolute as usually supposed, but relative to the material objects with which we are dealing.

The discrepancies between theory and practical experiments brought to light by Fizeau, Clerk-Maxwell and Lorentz led to the assumption that a so-called rigid body has no definite dimensions, and that when it is in motion it becomes shorter in the direction in which it is moving. A fairly simple formula, called the " Lorentz transformation," was devised for expressing the amount of this contraction. This formula was invented to cover these electro-dynamical and optical results, but it was unsatisfactory in that it was invented merely to fit a particular set of observations.

The Michelson-Morley experiment led to more fundamental conclusions, and it is worth while to devote a little time to it.

Imagine we are on a small island in the middle of a large river, and have no ordinary means of discovering which way the river is flowing. Suppose that a motor-boat is started off from the island in any direction and taken one mile in a straight line, and is then brought back to the island along the same straight line. Suppose, further, that this experiment is repeated in a number of different directions. It will be found that along one line—say north to south—the time taken by the motor-boat to complete the double journey will be a maximum, while in the direction at right angles—*i.e.*, east and west—it will be a minimum. From this we may conclude that

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the river is flowing from north to south or else from south to north. (This conclusion is based on a simple mathematical calculation.) We have thus discovered the direction of flow of the river.

Michelson and Morley applied this principle to the propagation of light through the ether. If the ether exists, there must be a current of ether flowing through or round the material objects on the earth because of the movement of the earth in its orbit (to say nothing of any movement of the solar or stellar system as a whole), and therefore the velocity of light in different directions ought to vary with the direction of the ether-flow—*i.e.*, it ought to be a maximum, say, along the east and west line, and a minimum along the north and south line. But no such difference in velocity could be discovered, although the accuracy of the measurements was quite sufficient to show this difference if it existed.

From this experimental fact that light moves at one and the same velocity in every direction regardless of the ether-flow, it is possible to show, by comparatively easy mathematical processes :—

1. That every body which is in motion contracts along the direction of its motion.
2. That a clock or other time-piece, *e.g.*, an oscillating atom, goes more slowly when in motion.

In each case the Lorentz transformation referred to above is arrived at, and it is obtained by a method different from that used by Lorentz himself.

These changes in length and time are, as shown by the Lorentz formula, very minute for any ordinary velocities, and thus escaped notice in classical mechanics, but they become appreciable or even very large at velocities approaching the velocity of light ; and thus the greatly increased accuracy of modern methods of measurement, combined with the fact that electrons moving with a velocity approaching that of light are used as the material of modern experiments, has made it necessary to take such changes into account.

Special and General Theories of Relativity.—The above considerations relate only to the case in which the motion is a uniform motion of translation in a straight line, and the ideas sketched out are embodied in what Einstein calls " the special theory of relativity," as published by him in 1905.

But if the motion is not uniform, or if it is in a curved line, the question becomes vastly more complicated, and we are led to what Einstein calls the " general theory of relativity," published by him in 1915. The formulæ in this latter theory are very lengthy, and it requires a super-wrangler to deal with them efficiently. Even the most advanced mathematician is obliged to disregard the more minute terms in these formulæ in order to reduce them to manageable

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limits, and in this less complicated form the formulæ are used for dealing with the most subtle phenomena hitherto observed.

If, again, other still less minute terms are omitted, we arrive at the formulæ of classical mechanics, which are fortunately accurate enough for the vast majority of practical purposes.

Time as a Fourth Dimension.—In these formulæ the symbol representing time is on all fours with the symbols which represent distances. In fact, time is regarded as a fourth dimension essentially indistinguishable from the three dimensions of space. We are thus led to the conception referred to above, *viz.*, the conception of a four-dimensional space ; or, to word it more accurately, we are led to the conception of a four-dimensional " space-time manifold," as it is called, in which manifold all the physical phenomena of nature occur.

This conception of time as a fourth dimension may be illustrated as follows :—

Suppose that a cinema film is cut so as to separate all the different scenes which it contains, and that these different photographic scenes are piled up in order like a pack of cards on a table. Then imagine that this pack of views is gradually pushed down through the surface of the table, and that the result is observed by a two-dimensional being inhabiting the surface of the table. Such a being would see each scene as it passes through the surface. He would not see the scenes which had not reached that surface, and they would, for him, constitute the " future." The scenes which had passed below the surface would constitute for him the " past." Thus, for our two-dimensional being time might be regarded as a third dimension.

Similarly, for us three-dimensional beings time may be a fourth dimension, and the passage of time may really be the passage of a four-dimensional body through our three-dimensional world, and our past, present and future may all be visible simultaneously to a four-dimensional being.

This is essentially the conception of time which is introduced into the relativity formulæ.

If, furthermore, we imagine the above four-dimensional body to be twisted round as it passes through our three-dimensional world (in the same way as we may imagine the pack of cinema scenes to be twisted round while it passes through the surface of the table), there would be, from our point of view, a distortion of both space and time corresponding to the distortion of space and time which results from suitable manipulation of the formulæ. In other words, we arrive at the philosophical idea that space and time are relative and not absolute.

From a mathematical point of view, this twisting round of the pack of cinema scenes or of the four-dimensional body is essentially

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the same thing as an alteration of the system of co-ordinates used for the relativity formulæ.

Further Results of Relativity Formulæ.—It remains now to mention three unexpected results which have been obtained by calculation from the relativity formulæ.

1. For many years astronomers have been puzzled by a certain feature in the motion of the planet Mercury. The longer axis of its orbit turns gradually round in a way that Newton's formulæ will not account for. This rotation of the orbital axis is completely accounted for by the relativity formulæ.

2. Einstein predicted that there would be a certain minute displacement in the apparent positions of stars visible near the sun during a total eclipse of the sun. This was tested during the eclipse of 29th May, 1919, and a displacement was observed which agrees remarkably well with the prediction. The amount of this displacement is so small that it is only equivalent to a shift of about one-thousandth of an inch as seen from a distance of ten feet, but the accuracy of the observations is such as to leave no doubt as to the reality of the displacement.

3. Einstein has calculated that the lines in the spectrum of the sun and stars are to a minute extent shifted towards the red end of the spectrum through the action of gravity. This has not been confirmed as yet, but there is some reason to think that it may be confirmed during the next few years.

In fact, it looks as if the relativity formulæ might include in one system, from a mathematical point of view, all the physical phenomena which have as yet been observed, including even gravitation, which it has hitherto been impossible to classify with the other forces of nature.

It may be mentioned that Professor Whitehead does not accept all the ideas put forward by Einstein, nor all the formulæ, but the formulæ deduced by these two authorities agree in all those cases in which it has been possible so far to test them by experiment or observation. Therefore, it is not yet possible to say whether Whitehead's views or Einstein's will ultimately be found to be more true to nature.

Complicated Character of Relativity Theory.—The relativity theory is far more satisfactory than the theories of classical mechanics, not only because it fits observed facts more closely, but also because it sweeps away various illegitimate hypotheses which have hitherto been adopted; as, for instance, the hypothesis that space and time are essentially different, and the hypothesis that gravitation acts instantaneously and at a distance. The reason for preferring the new theory is, in fact, the same as the reason for preferring the Copernican view of the world to the Ptolemaic view, *viz.*, that it leads in its broader aspect to a simpler system of mechanics.

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But the relativity theory, as indicated above, is far from simple when it is a question of applying it to observed phenomena. An illustration of this is given by Professor Eddington in connection with a certain equation which contains the innocent-looking factor 24. This number has been arrived at from an expression which contains 65,536 terms. It has been necessary to consider every one of these thousands of terms. Most of them apparently prove to have the value zero. But it is only when all these vanishing terms have been rejected, and the other terms have been taken into account, that Eddington is able to say, " I believe that the numerical factor 24 is correct."

Professor Weyl appears to have gone still further than Einstein and Whitehead, and to have developed a theory which is even more complicated in its application, but which there is reason to believe is, in a sense, simpler in that it will weld together electricity and gravitation into one geometry, and that it will pass experimental tests even more satisfactorily than the theories of Einstein or Whitehead. His views are, however, not altogether accepted either by Einstein or by Whitehead. Mons. Painlevé, too, has excogitated several possible laws of gravitation, differing from Einstein's, one or other of which may, after all, prove to fit the facts more accurately than any law previously suggested.

Essential Truth of the Mathematical Conception of the Universe.—In the sixth century, B.C., the Pythagoreans held the doctrine that " All things are numbers." They also held a doctrine of " The harmony of the spheres." Through the centuries down to the present time other doctrines have been held, until we come to the various systems of equations suggested by modern thinkers.

The question naturally arises :—What essential truth is there in these ideas, or in other words, why do the phenomena of nature conform to mathematical theories? The answer is that we choose our mathematical theories so as to conform to the natural phenomena. There is no reason known to us why the phenomena should conform to the theories.

As mentioned above, systems of geometry have been devised by taking certain axioms and dealing with them in accordance with certain logical processes. We have all of us been brought up on the axioms of Euclid, and, therefore, our minds find it very difficult to adopt any other axioms.

But in the nineteenth century there were bold and profound mathematicians—Riemann, Bolyay, Lobatchewski and Poincaré—who adopted other axioms, and founded new and different geometries. Thus, Euclid taught us that " Through a given point there can be only one straight line parallel to a given straight line." Riemann, on the other hand, assumed that " Through a given point there cannot be any straight line parallel to a given straight line "—that is to say,

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two straight lines will always meet somewhere. Upon this Riemann founded a quite consistent system of geometry.

All these different systems of ideal geometry are called by Einstein " purely axiomatic geometry."

The next step is to select one of these purely axiomatic geometries, and to adopt *as an hypothesis* the idea that it fits in with the phenomena observed in nature. Geometry, as so used, is called by Einstein " practical geometry." It is evidently a " natural science," and it may be regarded as the most ancient branch of physics. The recent advance which is puzzling so many of us merely amounts to this—that modern refined methods of measurement prove that the phenomena of nature do not conform to Euclidean axiomatic geometry, but that they seem to conform to one or other of the nineteenth century axiomatic geometries.

Incidentally it may be said that such paradoxical statements as " Time is a fourth dimension " and " Space has been found to be bent " could be more correctly expressed by saying, " The phenomena of Nature can be described more accurately than hitherto by the adoption of a geometry which postulates the existence of a fourth dimension analogous to the three dimensions of space, and by the adoption of Riemann's axiom on the subject of parallel straight lines instead of Euclid's axiom."

In other words, a purely axiomatic geometry has been discovered, in fact, perhaps several have been discovered, which fit the observed facts better than Euclidean geometry; and it remains now to be ascertained which of these new systems it is (as Poincaré puts it) more " convenient " to use.

Remarkable Conclusions.—A few of the remarkable conclusions obtained from the relativity theory may here be added :—

Two straight lines may enclose a space.

The three angles of a triangle are together not equal to two right angles.

The universe is unbounded but finite (as is the surface of a sphere in three-dimensional space).

With a sufficiently powerful telescope a man might look round the universe and see the back of his own head.

A so-called double star may be one single star seen simultaneously in two different directions.

A spiral nebula may be a blurred image of our stellar system, produced by light which has passed round the universe.

Gravitation is not a force; it is a distortion of space and time in the presence of matter.

The effect of the gravitation of the sun on a light wave moving radially (*i.e.*, directly towards the sun or away from it) is a repulsion. The effect on a light wave moving transversely is an attraction.

If we could utilize the fourth dimension, we could make bodies

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materialize or dematerialize, and we could turn a lawn tennis ball inside out without stretching or tearing it.

The mass of a body is not constant, as hitherto supposed, but varies with the motion of the body.

No material thing can travel with the speed of light, for it would require an infinite force to impart such a velocity to the smallest particle.

The word "ether" lacks physical meaning. All phenomena occur as if the ether did not exist.

If an aeroplane were travelling at 160,000 miles per hour, its length would appear to be halved, but the time taken by the aviator to smoke a cigar would appear to be doubled.

If a steamer is travelling at 20 miles an hour, and a man on board walks forward at 3 miles an hour, his speed relatively to the earth will not be 23 miles an hour but a minute fraction less.

The interval between a man's birth and death may be for one observer 1,000 miles and 75 years, while for another observer it may be millions of miles and 76 years.

General Attitude towards Mathematical Conceptions.—I have given above a slight sketch of some of the ideas introduced of late years into the mathematical conception of the universe. It might be also of interest to glance at some of the mental attitudes which have at various times been adopted by thinkers towards such a conception.

In the first place, with regard to its truth, Professor Cayley, one of the most eminent mathematicians of the nineteenth century, wrote as follows in his Presidential address to the British Association in 1883:—

"I think that it may be at once conceded that the truths of geometry are truths precisely because they relate to and express the properties of what Mill calls 'purely imaginary objects'; that these objects do not exist in Mill's sense; that they do not exist in Nature may also be granted; that they are 'not even possible,' if this means possible in an existing nature, may also be granted. That we cannot 'conceive' them depends on the meaning that we attach to the word 'conceive.' I would myself say that the purely imaginary objects, as Mill calls them, are the only realities, the *ontos onta* (things that really exist), in regard to which the corresponding *physical objects* are as the shadows in the cave (of Plato)."

(I am indebted to Prof. Sonnenschein for this quotation.)

As against this, I may quote the dictum of a distinguished living mathematician, Mr. Bertrand Russell:—

"Pure mathematics consist entirely of such asseverations as that, if such and such a proposition is true of *anything*, then such and such a proposition is true of that thing. It is essential not to discuss whether the first proposition is really true, and not to mention what the anything is of which it is supposed to be true. . . . Thus mathe-

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matics may be defined as the subject in which we never know what we are talking about, nor whether what we are saying is true."

We are, in fact, on the one hand told by Cayley that mathematical statements are the only truths, and on the other hand by Bertrand Russell that we never know whether such statements are true.

Again, for some thinkers mathematical theories seem to have an æsthetic aspect. That is to say, the contemplation of a formula, such as the binomial theorem, or the perception of a relationship such as that between the sections of a cone and the movements of the heavenly bodies, may induce a thrill analogous to that obtained from the contemplation of a beautiful sunset or the perception of a grand waterfall.

And again, religious awe may form an element in the mental attitude. " God thinks in sines and cosines " was the exclamation of one medieval thinker.

Richard A. Proctor was differently affected. He wrote as follows in his *Familiar Scientific Studies* :—

" I personally have often found relief from the dreary infinities of homaloidal space (that is, space where straight lines are straight and planes plane) in the consoling thought that, after all, this other (*i.e.*, non-homaloidal space) may be the true state of affairs."

It would have comforted him to read the modern evidence that our space is curved, and that straight lines and planes may ultimately bend back on themselves.

A feeling of religious awe is, of course, to be seen in the writings of many non-mathematical authors when they are contemplating the phenomena of Nature. " An undevout astronomer is mad." And it seems clear that for those of us who are mathematically inclined, however far we may lag behind the leading authorities on the subject, a similar feeling of religious awe may be associated with the equations and the geometrical forms which together make up the mathematical conception of the universe.

With these vague ideas I bring my paper to a close.

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STEAM RAISING BY LIQUID FUEL

By CAPT. J. H. DYER, M.C., R.E.

THE increasing demand for petrol and the lighter oils makes it essential to extract from the crude petroleum the maximum of these products, leaving a heavy residue suitable only for steam-raising, furnace work or Diesel engines. In cases where the petroleum has an asphalt base, certain of the residual products are only suitable for steam raising, as the asphalt is liable to cause scoring of the cylinder walls if used in Diesel engines.

The average calorific value of this product is 18,500 B.T.U.'s per lb. Oil firing has recently been widely adopted for mercantile marine as well as naval work, and a number of land plants are now adopting oil firing in place of coal.

SYSTEMS OF BURNING.

(*a*) *Mechanical-Pressure Jet.*—The oil is delivered at a pressure of from 20 to 150 lbs. per sq. in. by a Simplex steam pump through a steam heater to the burners, where it is forced through fine holes to emerge as an atomized oil mist.

(*b*) *Steam Jet.*—The oil gravitates from a storage tank through a steam heater to the burners, where it is drawn into the furnace and atomized by a steam jet (injection action).

(*c*) *Air Jet.*—The oil gravitates from a storage tank through a steam heater to the burners, where it is drawn into the furnace and atomized by a blast of air moving across the end of the oil pipe (injection action, similar to scent spray).

In all the above systems the oil is burnt in an atomized state.

(*d*) *Vaporization.*—The oil, under an air pressure (from 5 up to 50 lbs. per sq. in.) is passed through piping heated by the oil flame and completely gasified : example, Primus stove burner.

CHOICE OF SYSTEM.

(*a*) *Mechanical-Pressure Jet.*—This gives the highest efficiency, as there is no cooling down of the flame by steam as with the steam-jet system, and only about 3 per cent. of the boiler output is required for heating and jetting the oil (2 per cent. for heating + 1 per cent. for driving the oil pump). Boiler efficiencies of 80 to 83 per cent. are regularly obtained under good conditions. Unsuitable where boiler pressure is below 70 lbs. per sq. in., as the steam temperature

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is not sufficiently high at pressures below 70 lbs. to reduce the viscosity of heavy oils sufficiently in the heater for use with a pressure jet to give good atomization. Capital cost slightly greater than for other systems. Suitable for outputs of 3,000 lbs. of steam per hour and upwards; saving is greatest for a battery of boilers, as one pumping and heating plant can supply two or more boilers. This system has been exclusively adopted for marine work and for large land installations.

(*b*) *Steam Jet.*—Less efficient than pressure jet, as more steam is required than with the pressure system (from 5 per cent. to 8 per cent. of the boiler output for jetting + 1 per cent. for heating: total 6 to 9 per cent.). The steam does not promote combustion, as it must undergo dissociation before it can re-associate to promote heat. The steam displaces air which is required for combustion and also absorbs sensible heat, cooling down the flame (as the steam enters at, say, 400° F. and leaves with the flue gases at 600° F.). Boiler efficiencies of 70 to 73 per cent. may be obtained. Cheap in first cost and simple to operate and install. Used for single boiler work for small outputs and where generating low-pressure steam (say, below 70 lbs. per sq. in.). This is the system adopted for oil-fired locomotives.

(*c*) *Air Jet.*—High efficiency, only about 3 per cent. of the boiler output required for compressing the air, but the system is unsuitable for steam raising, as it tends to give an intense local heat, giving unequal expansions in the boiler. Suitable for metallurgical work, cupola, rivet-heating, galvanizing, muffle, billet-heating furnaces, etc.

(*d*) *Vaporization.*—Suitable only for very small outputs, such as a small boiler for obtaining steam for starting up a steam-jet or pressure-jet system. A light oil must be used or carbonization takes place in the heating coils.

DETAILS OF INSTALLATION.

(*a*) *Mechanical-Pressure Jet.*—Drawing shows system adapted to a Lancashire boiler. The oil passes from the storage tank (provided with a steam-heating coil to assist the flow in cold weather), through a coarse-mesh suction strainer, thence through a Simplex steam pump to a steam heater (consists of pipes inside which steam circulates, the oil circulating over the outside or *vice versa*).

From the heater the oil, at a temperature of 100° F. to 250° F., passes through a fine gauze filter which eliminates any particles of carbon liberated by the heating and which would tend to choke the fine nozzle holes in the burner, which vary from 1 to 2·5 mm. in diameter. Thence the oil passes to a distribution box, having a screw-down valve for each burner, enabling it to be cut out if necessary. When starting up, the burners are all cut out and the oil circulated round to the suction side of the pump until it attains

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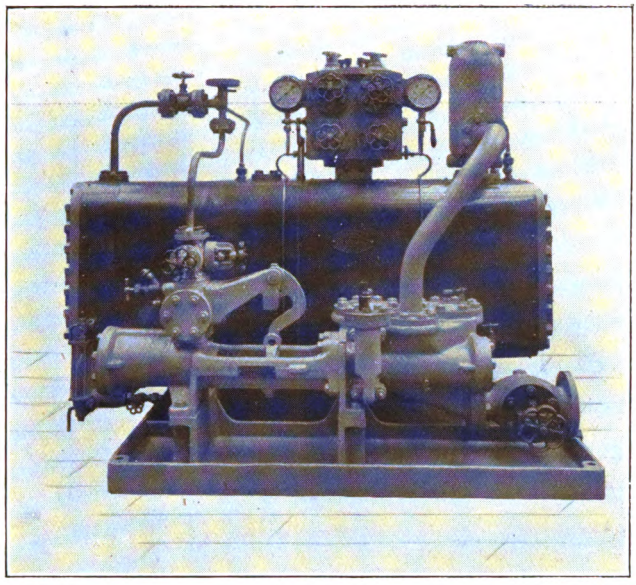

FIG. 1.

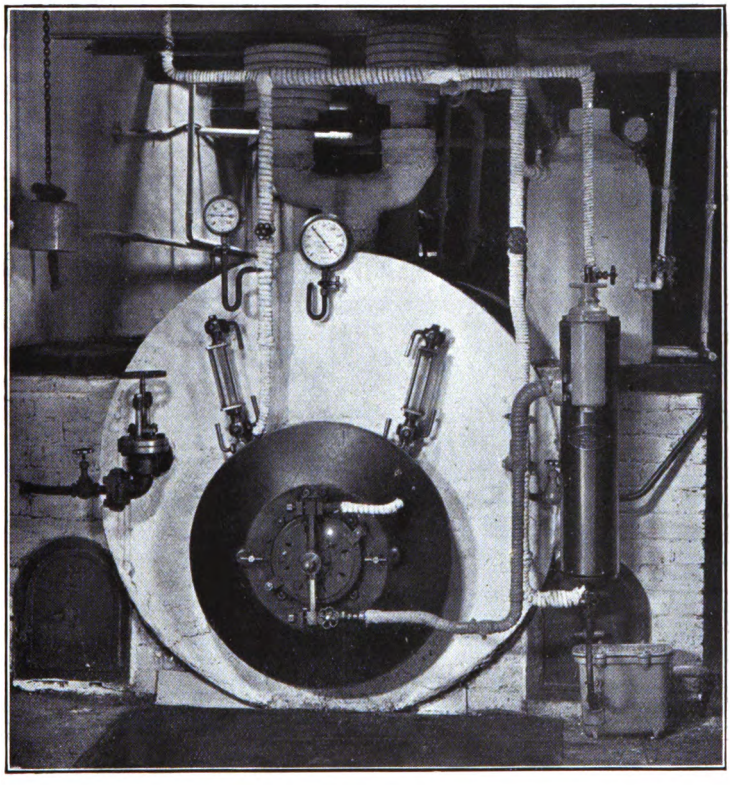

FIG. 2.

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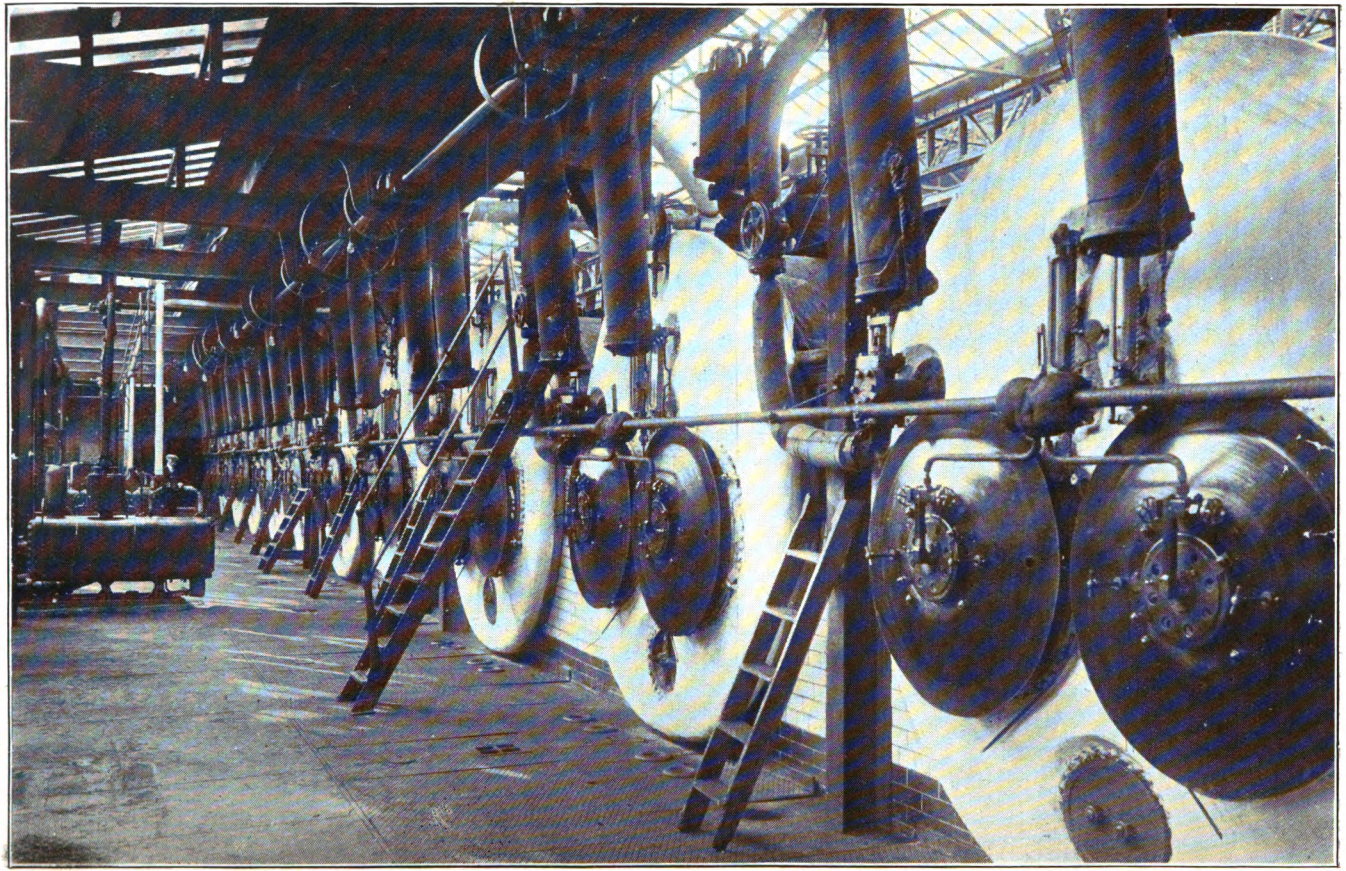

FIG. 3.

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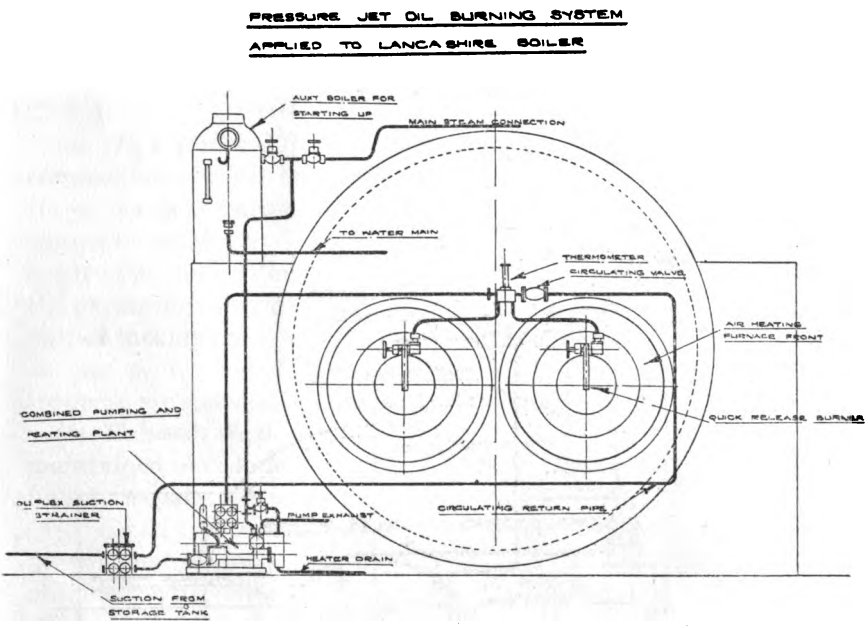
the correct temperature on leaving the heater, when the burners are lit up. The nozzles break the oil up into a fine mist, having a whirling motion, and air directors admit air with a whirling motion to give an intimate mixture of oil and air. The flame should begin about 2 or 3 inches from the nozzle, it should be short and in breadth and height should completely fill the cylindrical furnace flue in a



Shell boiler or the combustion space in a water-tube boiler: otherwise cold air will pass through to the flue between the edge of the flame and the inside of the furnace, greatly reducing the boiler efficiency.

(*b*) *Steam Jet.*—Drawing shows system adapted to a Cornish boiler. The oil is pumped direct by tank wagon to a storage tank, having a minimum head of 4 ft. from the bottom of the storage tank to the burner. No further pumping is necessary: the oil gravitates to the storage tank (which has a steam coil near the outlet to assist the flow in cold weather), through a small steam heater (the oil does not require to be pre-heated to such a high temperature with the steam-jet as with the pressure-jet system). Thence the oil gravitates to the burner or burners, where steam is used to induce and atomize the oil, in the majority of designs working on the scent-spray injection principle. It is very essential that the jetting steam should be absolutely dry; any moisture would tend to extinguish the burner and would cause rapid corrosion of the furnace tube due to the formation of sulphuric acid with the sulphur present in some fuel oils.

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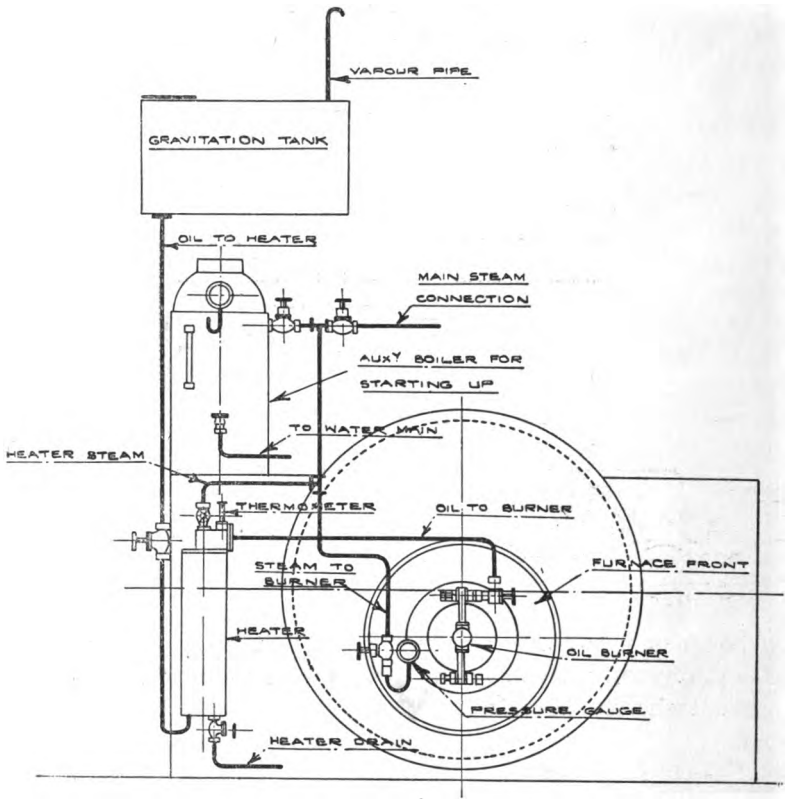
For starting up both the pressure-jet and steam-jet systems where all the main boilers are shut down, a small auxiliary boiler is required : this may be fired with rubbish, wood, town gas or a Primus type burner.

STEAM JET OIL BURNING SYSTEM.
APPLIED TO CORNISH BOILER



REGULATION OF OIL FURNACES.

(*a*) *Flame.*—Should be dazzling white ; if red and smoky, steam pressure is too low ; if the flame is ragged and tends to go out, the steam pressure is too high, in the case of a steam-jet system

(*b*) *Oil Temperature.*—Regulated by throttling the steam to the heater. Black smoke may indicate too low a temperature, while white smoke and carbon deposits in the furnaces indicate too high a temperature.

(*c*) *Air Admission.*—Controlled by flaps and shutters on the furnace front. Avoid smoke. Too little air gives black smoke, too much air, white smoke. Best combustion gives a faint trace of black smoke.

(*d*) *Oil Pressure.*—In pressure-jet systems varies from 30 to

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150 lbs. per sq. in., average 60 lbs. per sq. in. Black smoke is produced if the pressure is too high or too low. Work at the minimum pressure consistent with smokeless combustion and sufficient output of steam. If the demand for steam increases considerably (say, during peak load) it is better to alter the size of the burner (which can be done in less than one minute) than to vary the pressure widely from that found to give correct atomization with a given sample of fuel oil at a given temperature.

Advantages of Liquid Fuel.

(*a*) *High Boiler Efficiency.*—Due largely to perfect regulation of combustion. With oil fuel the excess air is rarely more than 20 to 50 per cent. in excess of the amount theoretically required for complete combustion, representing a maximum fuel loss of about 5 per cent. due to heating up the extra volume of air. With coal the excess air cannot usually be reduced below 100 per cent. to avoid risk of incomplete combustion: this represents a fuel loss of about 20 per cent. For best results great attention must be paid to stopping air leaks in the brickwork setting of the boiler and the flues.

(*b*) *Reduced Wear and Tear of Boiler.*—Uniform temperature is maintained over long periods. No sudden rushes of cold air causing uneven expansions when fire door is opened, as with hand firing.

(*c*) *Greatly Increased Capacity of Boiler.*—In many cases up to 50 per cent. more steam than could be obtained by coal firing is obtained with oil firing, without any appreciable falling off in efficiency from normal load.

(*d*) *Reduction of Labour Costs.*—Easier handling and stoking.

(*e*) *No Stand-by Losses*—No banking of fires, and steam can be quickly raised from cold.

Photographs.

Fig. 1 shows self-contained pumping and heating plant for Pressure-Jet System. This photograph shows clearly the pump, heater and duplex discharge strainer, enabling one strainer to be cleaned whilst running, without shutting down the plant.

Fig. 2 shows a Steam-Jet System applied to a Cornish Boiler. Note small starting-up boiler in background on right, also oil heater strainer and steam trap for condensate from oil heater in foreground on right.

Fig. 3 shows a large battery of Lancashire boilers converted from coal to oil firing on the Pressure-Jet System. Note the pumping and heating plant on the left. Each pumping and heating unit can supply six boilers.

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MEMOIRS.

COLONEL E. H. GROVE-HILLS, C.M.G., C.B.E., D.Sc., F.R.S.

EDMOND HERBERT HILLS was a man of outstanding ability, as all who knew him will agree. He impressed his contemporaries in the Corps as an officer of singular originality and capacity, and his career in the world of science justified the high regard in which he was held. For his host of friends his death is a grievous loss.

He was the son of Judge Hills, of Highhead Castle, Cumberland, and was born in 1864. Judge Hills had been, for many years, judge of the Court of Appeal in Egypt, and had previously been Secretary to the Lord Privy Seal, for which post he had been officially recommended by Dr. Jowett, the Master of Balliol. Edmond Hills's mother was a daughter of Sir William Grove, the eminent judge and man of science, the inventor of " Grove's cell," President of the British Association, and a prominent Fellow of the Royal Society. His uncle was Major-General Sir Coleridge Grove. Edmond Hills inherited excellent endowments of the mind from both sides of the family.

He was educated at Winchester, passed into Woolwich at the head of the list in 1882, and was commissioned in July, 1884. He went to Gibraltar for a tour of service in 1887, was promoted Captain in 1893 and in August, 1893, was appointed Instructor in charge of the Chemistry and Photography School at Chatham. At the end of 1899, on the outbreak of the South African War, he was selected for the important post of officer in charge of, what is now styled, the Geographical Section of the General Staff, at the War Office. It was during his service there that he did his most important work for the Army.

The Geographical Section of the General Staff is derived from the Depôt of Military Knowledge, which was founded by the Duke of York, then Commander-in-Chief, in 1803. The Section went through various changes in the course of the next century, and from 1877 to 1901 was known as " Section F." In 1904 the Intelligence Department was reorganized and Hills pressed successfully for an enlargement of the staff of the Geographical Section to enable it to fulfil its proper functions. Thanks to this enlargement and reorganization the Section was able, later on, to make adequate preparation for the Great War. The Geographical Section has, in the course of its

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Colonel E. H. Grove-Hills, C.M.G., C.B.E., D.Sc., F.R.S.

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history, had many distinguished chiefs, amongst whom may be named Sir Henry James, Lord Cromer and Sir Charles Wilson, but none of these rendered more excellent services to the cause of military geography than did Edmond Hills.

In 1905 he retired from the active list and in 1906 contested Portsmouth in the Conservative interest. He took up Army duties again on the outbreak of war in 1914, and served in the Eastern Command, eventually as Deputy Chief Engineer, with the rank of Brigadier-General. He finally retired as Colonel after the Armistice in 1918.

Throughout his life he took a keen interest in all branches of knowledge, but especially in physical science. Whilst Assistant Instructor at Chatham he developed, and greatly improved, the method of determining terrestrial longitudes by photographing the moon and star trails. More would have come of this method but for the introduction of wireless methods. He took an important part in three eclipse expeditions ; notably the expedition to Fundium in West Africa in 1893, when he obtained photographs of the spectrum of the prominences reaching further in the ultra-violet than had been obtained before ; and the expedition to Pulgaou, in India, in 1898. He was a member of the Joint Eclipse Committee. In 1906, in conjunction with Sir Joseph Larmor, he investigated the irregular movement of the Earth's axis of rotation. In 1914 he devised the suspended zenith telescope for use at Durham University. He wrote a number of scientific papers on a considerable range of subjects, such as the use of slit spectroscopes in the eclipse ot 1893, the optical distortion of a doublet lens, the " green flash " at sunset, and the suspended zenith telescope

In 1902 he was awarded the C.M.G. for his work in connection with the Chile–Argentina boundary dispute.

In 1907, on the recommendation of the Colonial Survey Committee, he was appointed to inspect and report upon the Survey Departments of British East Africa, Uganda, Ceylon, the Federated Malay States, and S. Nigeria. This mission was admirably carried out, and the suggestions made were almost all adopted.

Hills was elected Honorary Treasurer of the Royal Astronomical Society in 1905, and held the post till 1912. He resumed it at the special request of the Council of the Society in February, 1922. He was President of the Geographical Section of the British Association in 1908. He was elected a Fellow of the Royal Society in 1911. He was appointed Honorary Director of the Durham Observatory in 1913 and, in the same year, he received the degree of Doctor of Science at Durham. He was President of the Royal Astronomical Society from 1913 to 1915.

But, remarkable as his scientific activities were, it would be an entire mistake to regard him as having lived the life of a recluse,

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wrapped up in research and study. He had many out-of-door interests, and all his life thoroughly enjoyed shooting and fishing. Many of those who served at Gibraltar in the late 'eighties will remember happy shooting trips with him in Southern Spain, and in later years he was always the possessor of some good sporting place where he entertained his numerous friends.

In 1892 he married the daughter of J. Spencer-Bell, Esq., M.P. There were three children, two sons and a daughter. Both sons were, alas! killed in the Great War; a terrible sorrow, bravely borne by his wife and himself. A few months ago Edmond Hills was stricken with an incurable illness. It was thought that he might be spared for a year more of life, but, perhaps mercifully, this was not to be. He died on the 2nd October, having faced the end with the greatest fortitude.

Those who were privileged to be counted amongst his friends will retain in their minds the picture of a man devoted to science, transparently sincere, a brilliant talker, who would illuminate any discussion with striking and original ideas and contributions from the treasures of a remarkable memory; a man of equable disposition, not easily provoked, who took a broad, sane outlook on the affairs of life.

And so passes a brother officer of fine character and unusual ability. Peace be to his memory.

C.F.C.

COLONEL HENRY S. ANDREWS-SPEED.

HENRY ANDREWS-SPEED, son of James Andrews-Speed, merchant, of Gibraltar and Malaga, was born at Gibraltar on the 6th June, 1852. He was educated at Wimbledon School, whence he passed into the Royal Military Academy at the examination of December, 1870. Youngest member of a large family, he had at the age of thirteen lost his father, and he was thereafter given a certain control over the funds left for his education. He determined to compete for Woolwich, and he made all those arrangements himself which usually devolve on parents or guardians. This experience rendered him exceptionally self-reliant. He joined the Academy early in 1871, and in March, 1873, received a commission in the Royal Engineers which was ante-dated September, 1872. After the usual two years' course of instruction at Chatham, followed by a brief period of home service, he embarked in January, 1876, for Bermuda. Two years later he was transferred to Malta, where he remained until January, 1881. A few months in England were followed at the end of the year by embarkation for India, to which land he devoted the rest of his service.

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Joining the Madras " Queen's Own " Sappers and Miners at Bangalore in January, 1882, Lieut. Andrews-Speed soon saw active service. An Indian contingent under Sir H. Macpherson was detailed to form part of Sir Garnet Wolseley's Egyptian expedition of 1882, and Andrews-Speed accompanied the contingent as Company Officer in the Madras Sappers and Assistant Field Engineer. He went through the campaign, was present at the battle of Tel-el-Kebir on the 13th September, and received the Egyptian medal and Khedive's star. Returning to India in October, he served for three years at Bangalore and Ootacamund, obtaining his Captaincy in September, 1884, after 12 years' service.

In the province of Mysore the great annual festival of the Dusserah is celebrated with peculiar fervour by all classes, from the Maharaja downwards; and it is the practice of the native officers of Indian regiments to assemble on these occasions and glorify their European superiors. At the Dusserah of 1885 the native officers of the Queen's Own Sappers and Miners at Bangalore thus expressed themselves regarding Captain Andrews-Speed :—

" We sing in praise of Captain Speed, who possesses a charming countenance, and one who is at all times bent on the good of the men entrusted to his care. We sing in praise of one who is heroic in actions, and one who well merited war decorations for the part played in the Egypt war."

Through the veil of quaint native phraseology one can discern the genuine affection and respect in which the subject of this memoir was held by his Company and Corps.

Towards the end of 1885 Captain Andrews-Speed was selected to accompany the expedition to Upper Burma under General Sir Harry Prendergast, v.c. Embarking on the 4th November, he commanded " D " Company, " Queen's Own " Sappers and Miners, and took part in the capture of Pagan, Myingian, Ava and Mandalay. On the fall of the capital King Thebaw was dethroned and sent to India as a State prisoner. Captain Andrews-Speed, who received the Burma medal and clasp, returned to India in August, 1886, and resumed duty at Bangalore. Having accepted the conditions of continuous Indian service offered to R.E. officers in India, he went home in February, 1888, to join the Indian class of that year at Chatham. A year later he returned to India and, entering the Military Works Department, served four years at Bangalore and three at Umballa. In January, 1893, he married at Bangalore Ethel, daughter of Major-General Alfred Anderson, Indian Army, by whom he had two children, a daughter and son.

A year's leave to England from October, 1896, was followed by eighteen months' service at Aden, during which Major Andrews-Speed made a brief trip to India for examination in Tactical fitness to command—a test he passed at Mhow in December, 1898, under

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General Sir Richard Westmacott. While at Aden, he sat as a member of the Harbour Trust, and received from the Board at his departure a glowing tribute to the value of his services. After a period of six months' leave to England he returned at the end of 1899 to Indian Military Works, first at Ootacamund, and afterwards at Madras combined with Wellington. In 1901 he suffered a severe attack of enteric fever, and lay unconscious for many weeks, during which his life was despaired of. He, however, made a gradual but complete recovery, and after a year's leave, resumed duty at Madras and Wellington. He was promoted substantive Colonel in August, 1903, and two years later was transferred to the Poona Division, whence he retired in June, 1906.

On quitting the service Colonel Andrews-Speed settled with his family at Cossington, Somerset, whence he removed in 1910 to Enmore, near Bridgwater, occupying himself with gardening, carpentry, golf, various parochial services and the social amenities of the neighbourhood. At the outbreak of war in 1914 he made offer of his services, but was informed that applications from officers over 60 years of age could not be entertained. In 1915, however, his knowledge of Spanish and Italian led to his employment in the Cable Censor's office in London, where he remained four years. His labours were very exacting, involving much night-work.

The death in September, 1921, of their only son, a young man of high promise, was a crushing blow to Colonel and Mrs. Andrews-Speed. The father's health failed from that time, but it was not until August, 1922, that signs of a mortal malady were discerned. He bore his illness with profound patience and resignation, and expired on the 23rd October at Enmore.

The watchword of Henry Andrews-Speed's life was Duty. In the performance of duty, of which he had a lofty conception, he never spared himself. He was a keen soldier, and seized every opportunity of seeing active service. His modesty and his reserve concerning himself concealed a certain bull-dog tenacity; and he was no respecter of persons, speaking his mind to his official superiors as to his subordinates. He possessed ample common-sense, formed his judgments deliberately, and adhered to them. He was an excellent companion, always cheery and full of amusing anecdote; and he displayed a quaint and whimsical humour in conversation and correspondence. These qualities made him popular wherever he went. He was a sound churchman who did good by stealth, and a trusty friend who could always be depended on. The present writer was privileged to enjoy his friendship for more than half a century. His loss, irreparable to his widow and daughter, will be regretted by his many friends in and outside the Corps.

H.D.L.

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Colonel Henry S. Andrews-Speed.

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HISTORY OF THE GREAT WAR—MILITARY OPERATIONS, FRANCE AND BELGIUM, 1914.

Compiled by BRIG.-GENERAL J. E. EDMONDS, C.B., C.M.G., R.E. (retired), *p.s.c.* (Macmillan & Co., Ltd. Vol. I. with 8 Sketches of Operations. 8vo. Price, 21s. net. Thirty-four General, Battle and Situation Maps in separate case. Price, 21s. net.)

THE first volume of the Official History of the Great War has now been published. In the preface Brig.-General Edmonds states:—"The present volume covers events from mobilization up to the middle of October, 1914" (the last days of the B.E.F. on the Aisne) "only, a period of two and a half months, and is on a scale which to a large extent treats the battalion, squadron and battery records as the basis of the story. In succeeding volumes it will not be possible or desirable to adhere to this, and successively the brigade, division and even corps may become the unit of narrative. For this volume the scale adopted seems appropriate, in view of the importance of small units in the early operations, of the lessons to be derived from the study of the work of these units in open warfare, and of the desirability of leaving a picture of what war was like in 1914, when trained soldiers were still of greater importance than material, and gas, tanks, long-range guns, creeping barrages and the participation of aircraft in ground fighting were unknown."

A review of this important work will appear in the next number of the *R.E. Journal.*

NOTICES OF MAGAZINES.

MILITÄR WÓCHENBLATT.

Nos. 10 *to* 13 *incl. September,* 1922.

THE custom has come down to us from the long ago of ancient times that he who is the loser, whether it be in mere sport or in the more serious field of industry which Prussia made her particular occupation, shall be called upon to pay a penalty; the custom has in the past very generally been acted upon, and, when Germany has been the winner in a war, she has demanded a very strict observance of the custom. It would appear that in very recent times Germany's views upon the subject have undergone a radical change. In an article contributed to the *M.W.B.* for September 2nd (No. 10) by Lieut.-General v. Altrock, a regular tirade is delivered against the "villainous" Treaty of Versailles, which, it is demanded, shall be referred to a *neutral* Court of Arbitration (*sic*) for revision. The General seizes the opportunity

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to call upon his countrymen, whether they be University Professors or mere ignorant labourers, to unite together for the purpose of exposing the "uncivilizing policy" of the Entente Powers. In the same number of the *M.W.B.* in an anonymous article, entitled "The Best Answer for Poincaré," attention is called to the speech made recently by the French Premier at Thiaucourt, when very strong language was used by him with regard to Germany's methods of conducting war. The remarks made on that occasion are much resented in Germany, and it would appear that there are people in that country who hold that the result of the trials of the War Criminals at Leipzig has been completely to refute the idea that there was anything exceptional in the methods adopted and course pursued by Germany in connection with, or during, the Great War. Not only is Germany completely exonerated, but it would appear that she has been most forbearing in not utilizing her chief weapon of defence, which apparently consists in some formidable counter-list in which are set out charges against Entente War Criminals! The said counter-list has been prepared officially, and a demand is now made for its production, as by its publication, somehow, Germany's honour will be vindicated.

The military situation in foreign lands receives its share of notice in the September issues of the *M.W.B.* Lieut.-General v. Winterfeldt deals with the situation in Poland and the Border States in the number for September 2nd. He informs us that the scheme for a two-years' period of colour service—the project is not yet Law—will provide Poland with a peace-time Army of 300,000 all ranks, which on mobilization will be capable of expansion up to a million men. It is stated that there has been a reduction in the number of the French Commissions in the military districts, but at the same time the number of officers serving individually with the Polish Army has increased. Poland, it is said, has experienced disappointment at the turn which events took at the Genoa Conference. The Border States, it is alleged, are on the whole opposed to the provisions contained in the Treaty of Warsaw, signed last March: they feel that, both politically and commercially, it will be injurious to their best interests should they become more closely bound to Poland, as planned by the said Treaty. Lieut.-General Balck undertakes the task, one which, no doubt, is congenial to him, of passing in review, in the issues for September 2nd and 9th, the situation in Great Britain. Naturally, the articles open with a reference to the differences which arose between Great Britain and France in August last. The General thinks that the policy pursued by France in increasing her Air Force and submarines is causing concern in this country, as these war preparations must be aimed against Great Britain. Dealing with the domestic aspect of Great Britain's affairs, the General credits the political leaders of the country with great astuteness in having erected a Free State in the south of Ireland: it is alleged that they have intentionally adopted the despot's maxim, *Divide et impera*, as the keynote of their policy. Ireland having been split up into fighting factions, England can now look contentedly on, whilst the disputants settle their quarrels between themselves. India, too, comes in for a share of attention. The crisis which led to the resignation by Mr.

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Montagu of his office as Secretary of State, and Lord Sydenham's article in the *Revue de Paris*, in which the Indian situation is discussed, are both touched upon; Lord Sydenham is alleged to be supporting the cause of the reactionaries. A summary of the Establishment provided in the current Estimates for the British Army is set out: the reduction in the British Army of to-day as compared with that of pre-war days, and the deficiency of 32,000 men in the Territorial Army are particularly mentioned. As might be expected, the results of the Washington Conference receive attention at the hands of General Balck. He refers to the resolution passed at the Washington Conference involving a curtailment of Naval expenditure, and expresses the opinion that Great Britain will not be running any serious risks in cutting down the number of her fighting ships. The situation of to-day is compared with that which came into existence in 1815, after the conclusion of the Napoleonic wars, when Great Britain emerged victorious and was able, in consequence, materially to reduce the size of her Navy. The Air Arm is also brought under review, and the decision arrived at to maintain the Royal Air Force as an independent organization, with a definite rôle assigned to it in the British defence scheme, is noted. The manœuvres carried out in the Channel in the beginning of July last, when an attack was carried out by an Air Squadron on the Fleet engaged in mimic warfare, is commented upon and attention is called to the large percentage of hits scored by the airmen on that occasion. The agitation, in Parliament and in the Press, which followed, is duly noticed, as well as the decision taken to increase the Royal Air Force units. General Balck shares the views of those who hold that our Island Kingdom can no longer rely on a Navy alone for the adequate protection of its shores against external foes, but must also at the same time be strong in the Air and provide itself with adequate means to deal with aerial attacks. The situation in Switzerland is dealt with in an anonymous contribution published in the issue for September 16th. The Genoa Conference comes in for some ridicule. So far as Home affairs are concerned, the matter of highest importance consists in the very drastic reduction in the vote for the Army: so great has been the reduction that it would appear to be in contemplation to abandon the principle of universal service in Switzerland, at least temporarily. The annual contingents now being called to the colours are so small that one fusilier company is being suppressed in each battalion, which now consists of three fusilier companies and one machine-gun company. Again, owing to the shortage of funds, considerable delay is taking place in the proper equipping of the various units of the Army with such necessaries as range-finders, heliographs, trench-mortars, Very pistols, etc. The projected increase in the number of long-range guns is also held up; and even such important matters as the training of reservists and the customary autumn manœuvres are now in abeyance.

Oberleutnant Kurt Hesse, the author of *Feldherr Pshchologos*, completes, in the issue for September 10th, his article on the value of psychology in military training. In the concluding part of the article the subject is treated under four heads: (*a*) the training of general levies; (*b*) instruction in military schools; (*c*) the advanced instruction

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of officers; and (*d*) the scientific treatment of problems. Oberleutnant Hesse emphasizes the importance of selecting only first-class men for the instructional staff of military schools; a matter which apparently was not as carefully handled in Germany as it should have been in the pre-war days. The reduction in the size of the German Army has brought about a very wide distribution of the Officer Corps and it would seem that Regimental Commanders can no longer play the part that they did in the Kaiser's Army in connection with the advanced training of their officers. It is, therefore, urged that officers who show sufficient ability ought to be given an opportunity of obtaining higher education by being passed through the Universities and the Technical High Schools. Psychology, as a subject of study, is attracting considerable attention in the German Army to-day: in the issue for September 16th a correspondent, who served for four years during the Great War as a Company Commander, contributes his views, anonymously, on the subject in an article entitled *Psychologie und Taktik*. He relates some of his experiences on the Balkan Front and claims to have made the discovery that psychology and tactics are intimately bound up together.

The question of Staff appointments and the duties of regimental officers are discussed in an anonymous article, appearing in the issue of September 9th, from the point of view of a "career." The ambitious officer is as anxious to escape from regimental duties in Germany as he is in many other countries. In consequence, on the expansion of the German Army in the early days of the Great War, large numbers, if not the whole, of the regular officers of the Kaiser's Army left their regimental units to join the Staff. This condition of things did not altogether promote the best interests of the German Army as a whole: the command of battalions and companies passed into the hands of the Reserve Officer and the Kriegleutnant, who, however ready to serve their country, were not properly qualified to undertake the responsibilities thrust upon them. The results which followed were most unfortunate: the prestige of the officer class was lessened thereby in the eyes of the men; the non-commissioned officers, at the same time, increased their authority and began to clamour for promotion to commissioned rank, in spite of their lack of qualifications for the higher positions. Again, the failure to recognize and reward the services of regimental officers had the effect of disheartening them and led to a general disparagement of the status of the regimental officer. It is rightly pointed out that, however brilliantly a staff may plan operations, yet, if there are not efficient regimental officers to carry such schemes into effect, the high quality of the staff loses a considerable part of its value from the practical standpoint. The mischief which was done in the matter during the war has had an after-effect: the Socialist Press in Germany is now carrying on a campaign with a view to bringing about a replacement of the former class of officers by those of the understanding and training of non-commissioned officers. Owing to the paucity of officers now serving in infantry units, the non-commissioned officer is still in the ascendant, and has to play a prominent rôle in the training of the recruits. The complaint is made that whilst the

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non-commissioned officer who is engaged in clerical duties has good openings in civil life on the termination of his colour srevice, on the other hand, the non-commissioned officer who is engaged on, perhaps, the more important duties " on the square," has an exceedingly poor chance of obtaining lucrative employment on passing into the reserve.

Notices are published on two important works: in the issue of September 16th, on *Wehr und Waffen*, 1914–1918, by General v. Wrisberg, and, in the issue of September 23rd, on *Ballistik* by Dr. Theodor Vahlen. General Wrisberg was, during the years of the Great War, in the Prussian War Ministry, and gives an account of his experiences in connection with the provision of arms, ammunition and equipment for the portion of the German Army with which he was particularly concerned. The interesting statement is published that during the first month of the Great War 100,000 rifles were lost in the German Army, and it became necessary, therefore, to issue obsolete types of rifles, and even captured weapons, to the Lines of Communication troops and those in the Home garrisons. To those who have been directing their criticisms against the Prussian War Ministry, the reply is made that the French Army took the field in 1914 with an obsolete type of the Lebel rifle (model of 1886), and that there was a similar unforeseen wastage in France, where the authorities had to resort to the issues of converted rifles manufactured so long ago as 1874. A defence is also put up to the charge that the French field artillery was greatly superior to the German: it is met by the statement that the armament of the German field artillery consisted, as to 20 per cent. thereof, of light field howitzers, and that the French had nothiug to compare with them from any point of view. General v. Wrisberg provides important information on many other points. Dr. Vahlen's work deals mainly with the mathematical theory of ballistics and is said to be one of the most valuable of the contributions made to this branch of military literature.

W. A. J. O'MEARA.

TECHNIK UND WEHRMACHT.

The two Double Numbers, 7 and 8, 9 and 10. 1922.

Technik and Wehrmacht is a periodical of considerable interest to technical soldiers. There are several articles dealing with gunner questions. One, " Relativity and Gunnery," may develop into something of interest in the next volume, although, so far, the title is more ambitious than the matter. The history of mechanical transport of artillery, 1914–1918, and a review of " Ballistics " by Professor Vahlen are also worth reading.

Engineering is represented by a short description of a single trestle footbridge, two planks wide, of simple construction, and by a review of the first volume of Major von Kretschmann's book on the reconstruction of railways on the western front, a review of which appeared in the last number of the *R.E. Journal*.

The most interesting articles, however, are those which deal with the third volume of General von Wrisberg's memoirs. *Wehr und Waffen*

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(the title of this volume) deals with the activities of the Kriegsministerim in the design and provision of technical stores and new weapons. An extract on the tank question is printed at length. In General von Wrisberg's opinion Germany could not have overtaken the start we had secured in the construction of tanks before their first appearance on the Somme. He considers that the lack of raw material, workshop facilities, etc., would have prevented it. As contributary causes he states that tanks were not used by the Allies in sufficient number to overcome anti-tank defence before the summer of 1918, and that for this reason German Headquarters were not convinced of the necessity of building them in number until it was too late. Ludendorff comes in for a certain implied criticism in that he failed to see the importance of the subject and considered them of less value than a regular supply of guns, trench-mortars, machine-guns, etc., whilst the number of mechanics employed on U-boat and aeroplane construction was not interfered with. Von Wrisberg is emphatic in his opinion that isolated tanks constitute no formidable danger.

This volume does not please all its critics. Captain Jussrow, writing from a technical man's point of view, has a tilt at the " altpreussische Geist " as illustrated by the German Corps of Officers in general and by General von Wrisberg in particular. He complains of a lack of technical foresight before the war and a lack of recognition of the services of technical officers during and after the war.

Volumes 4 and 6 of the official series *Schlachten des Weltkrieges*, 1914–1918, have appeared and are reviewed by General Schwarte. Volume 4 deals with the capture of Novo-Georgievsk. Volume 6 describes the fighting on the Lorraine front, " von Nancy bis zum Camp des Romains " in August and September, 1914. The German lack of success and heavy losses on that front are attributed to faulty deduction from the capture of Liége and Namur.

It is stated that the 6th and 7th armies were given none of the information which had been collected in peace regarding the armament or organization of the French defensive arrangements, and the opinion is advanced that reserve and territorial formations should have, if anything, more artillery than first line troops, instead of less, as was the case with the German troops engaged.

H. ST. J. L. WINTERBOTHAM, *Colonel.*

REVUE MILITAIRE GÉNÉRALE.

July, 1922.

The Revision of the Regulations embraces the seventh period, *i.e.*, from the commencement of the Allied offensive on 18th July to the signing of the Armistice on 11th November, 1918. The conditions under which the German offensive in the spring was opposed are first described.

I.—*The First Battle in the Open.*—On 21st March the Germans succeeded in forcing a way through to open ground, and the French troops hastened up to fill the gap, and not trained as the Germans had

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been, were inexperienced in this type of combat after their three years of position warfare. Want of information, or at least uncertainty as to the enemy's movements was at first a great difficulty; events succeeded each other very rapidly. In these circumstances plans should be based on the commander's intentions rather than on the situation of the enemy, and orders issued in short general terms, leaving details to be worked out by the junior commanders, especially in the case of the improvised defensive. Moreover, the fronts held by the larger formations were more extended than in the war of position, and tended to be split up into fighting groups, separated by intervals covered by fire alone. Infantry experienced a feeling of isolation to which they had to grow accustomed, since they could no longer depend on the immediate and constant support of artillery, which either could not come into action at once, or, when in action, had not always ammunition sufficient for the multifarious duties lately demanded from it in position warfare. In nearly every division the distribution of the guns was revised; in some they were under the orders of the Divisional Commander, in others at the disposal of the infantry regiments in front line. The telephone as a means of communication failed entirely, and artillery, as a general rule, had to be contented with the 1/80,000 map for all purposes.

On the other hand, the enemy's artillery fire was no longer so powerful, and concentrations of gas-shell were not to be feared, so that it was possible, within reasonable limits, for the infantry to take greater risks. Still, the inaptitude of the troops for open warfare was marked; the higher commanders issued orders in too great detail and frequently too late to be of use, the infantry had almost lost the idea of manœuvre and kept looking for the support of artillery, while the only activity acquired by the last-named was that of precision achieved by processes inapplicable in a war of movement. It could not make use of the ground, and, deprived of telephones, showed little dash, awaiting accurate information before firing and losing many favourable opportunities. The junior commanders, so long deprived of initiative, hesitated to come to decisions based on the necessities of the moment, although events at Verdun and on the Somme had shown that, after the first assault, battle would have to be engaged on, or against, improvised positions.

General Foch directed the commanders of the Allied Armies towards essentially active warfare, in which the formal procedure of the Instruction of 31. 10. 17 would be no longer applicable. To General Pétain he wrote, " Our offensive must not aim at objectives limited of our own free will . . . if we attack it must be to beat the enemy and disorganize him as much as possible, and the battle entered upon with this object must be as rapidly as possible pushed home as far as possible, and not aim simply at ameliorating the situation of the moment. . . ." However, this doctrine could not be stated in full till rather later—*Directive* No. 5 of 12th July, 1918—on the eve of the general resumption of offensive operations by the Allies.

II.—*Return to Simple, Bold and Rapid Procedure.—Directive* No. 5 of 12th July, 1918, completed by a Note of 6th November, 1918, defines the new conception of offensive operations, and the *Instruction* of 31. 10. 17, was now only considered as " a collection of technical in-

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structions from which a commander is at liberty to make a choice." Simple, bold and rapid action will ensure strategic surprise by secrecy in the preparations, tactical surprise by suddenly delivered attacks, deep penetration and an immediate and far-reaching development of the success by rapid and sustained pressure. The *Directive* enjoins secrecy as a point of honour on all ranks, and recommends short, concise orders, leaving the means of carrying them out to the initiative of the recipient. The artillery preparation will be as short and violent as an ample supply of heavy quick-firing guns, using gas and smoke shell for neutralizing the opposing forces, will admit of, and can even be omitted if tanks can be counted upon. Rapid progress depends not on an increase of pace, but on rapidly surmounting obstacles; deep progress on aiming from the outset at a distant objective without any *a priori* restriction due to thoughts of ill success. The prompt capture of the ground occupied by the enemy's artillery is the best guarantee of rapid and deep progress. To exploit the success reserves must be employed to ensure sustained effort and prevent the enemy from re-establishing his situation. When a breach is to be made, infantry divisions should cover fronts of 2,000 metres or less. From the infantry is demanded initiative, boldness, and flexibility, an advance in communication with neighbouring troops, but without exact alignment, and faith in the possibility of exploiting its first success with its own resources in armament without artillery support. Artillery will afford infantry as constant and powerful support as possible, and it may be useful to place batteries or sections at the disposition of divisional, regimental, or battalion commanders. This procedure, already practised in the defensive, was employed during the French offensives with general satisfaction, so much so that a Note of 25th October, 1918, promulgated rules for the more efficient utilization of guns accompanying infantry, and for their rapid centralization in the hands of the divisional general or *vice versa*. A Note of 6th November revised these rules to ensure continuity of action, especially if the enemy made a definite stand, and to check a tendency to too great decentralization leading to disjointed local actions. *Directive* No. 5 thus returns to sound principles from which an extended period of stabilization and defective means had compelled departure. The attempt of the same nature made at the end of 1916 unfortunately failed owing to lack of means and modification of the doctrine, or the operations of 1917 might have been more decisive.

III.—*Application to the Offensive Operations in* 1918 *and Open Warfare.*—Here follows a short summary of the Allied offensive, which opened on 18th July with a brilliant counter-attack long prepared for by General Foch. By intelligent application of the principles enunciated above the Allies finally brought the war to a conclusion, and the Armistice was signed on 11th November, 1918. At this date the Allies had 205 divisions in the field, of which 103 were in reserve, while the Germans had 184 only, of which 17 in reserve.

A. R. REYNOLDS.

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R.E.
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THE ROYAL ENGINEERS JOURNAL.

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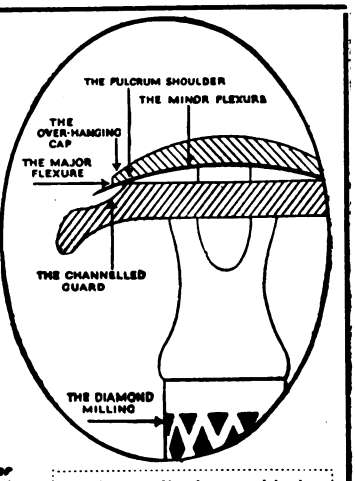

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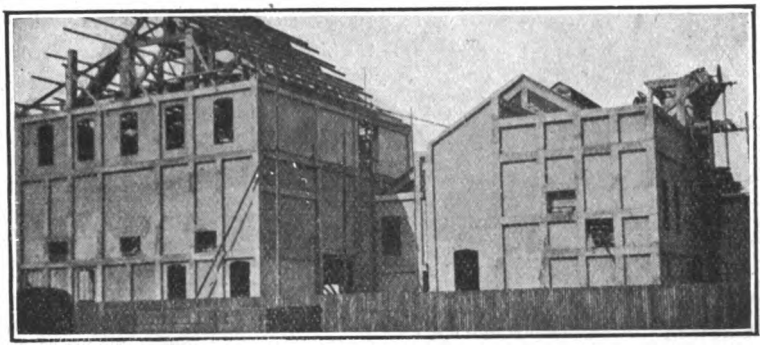

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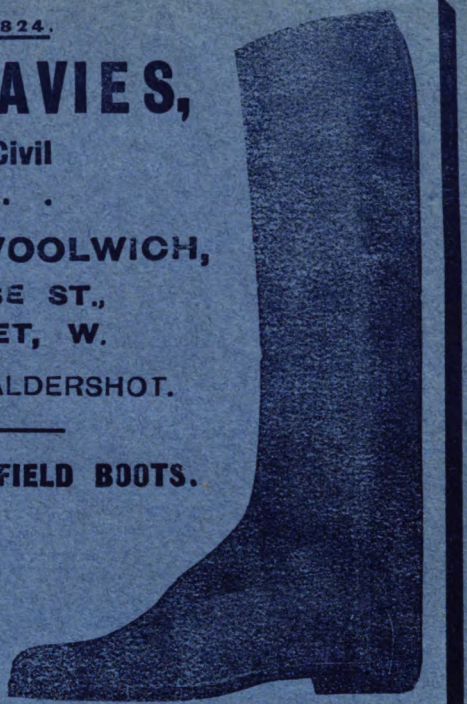

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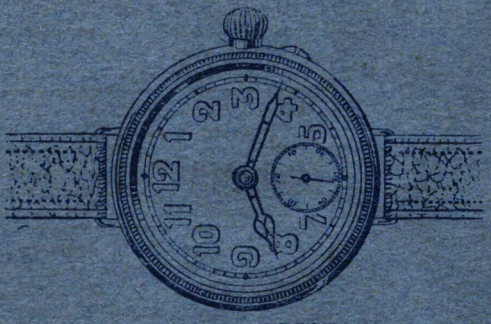

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